KING COUNTY CONVEYANCE SYSTEM IMPROVEMENT PROJECT

TASK 240

SOUTH SAMMAMISH BASIN WASTEWATER SERVICE ALTERNATIVE DEVELOPMENT

OCTOBER 2003

South Sammamish Basin
Wastewater Service Alternative Development

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DEVELOPMENT OF WASTEWATER ALTERNATIVES

This report develops a range of alternatives to allow flexibility in managing wastewater in the South Sammamish Basin and meet King County's sanitary sewer overflow (SSO) standard through 2050[1]. The key to the flexible approach is identifying and analyzing a large number of alternative components, each of which would provide relief to a stressed part of the conveyance system. The components, which consist of facility upgrades/upsizing, demand management, peak flow attenuation and flow diversion/redirection, can be combined in a mix-and-match fashion to form a comprehensive plan for meeting all wastewater service needs.

By considering more than the conventional large pipe/pump/storage solutions, we can better incorporate a variety of planning objectives in addition to controlling the 20-year peak flow, such as meeting operation and maintenance needs through the full range of flow conditions, phasing construction and capital expenditure, and integrating with the Brightwater Treatment Plant and Regional Infiltration and Inflow (I/I) projects. Additionally, developing a flexible approach to managing wastewater allows and encourages greater input by County and local agency personnel during the decision making process.

CONVEYANCE SYSTEM AND HYDRAULIC CAPACITY OVERVIEW

This section reviews the current conveyance capacity in the South Sammamish Basin and projected future wet weather peak flows. Comparing future peak flows to existing system capacity identifies which facilities will require upgrades and when these upgrades must be put in place. The County's South Sammamish Basin wastewater infrastructure was originally built in the 1960s and was expanded in the 1980s. Periodic facility upgrades are to be expected in this basin. Rapid development and population growth has occurred for the past several decades, and current forecasts predict further development in the coming decades.

[1] The King County standard, as set out in the Regional Wastewater Services Plan (*RWSP*), states that wastewater conveyance facilities are to limit unpermitted discharges from the sewer system to an average of once per 20 years.

Flow Projections

The King County Wastewater Treatment Division (KC WTD) prepared the flow projections used in this report. The flow projections comprise sanitary sewer base flow and I/I components. This section contains a brief overview of the analysis method used to derive the South Sammamish Basin flow projections; a more detailed discussion is included as Appendix A[2].

Base wastewater flows were computed using population forecasts and the County's standard unit wastewater generation rates from the *RWSP*[3] and then validated with available dry weather (or inter-storm) flow monitoring data. Two sets of population forecasts were presented in Task 210; one set was based on data provided by the Puget Sound Regional Council (PSRC), and the other set was provided by local agencies. The difference in the population forecasts affects the base wastewater projections but has less impact on the peak 20-year flow, which is heavily influenced by I/I volumes.

The I/I portion of the peak flow was computed using a hydrologic I/I model and performing a statistical analysis of the model output. The South Sammamish Basin was divided into six modeling basins, corresponding to the major tributary areas to each of the County's conveyance facilities in the area (Figure 1 and Figure 2). For each of these modeling basins, the I/I model was calibrated to available flow data[4], and then long-term simulations were run with the calibrated models to determine the magnitude of specific storms (e.g. once in 5 years; once in 20 years) for the existing sewer system. The King County modeling team made assumptions about the expansion of sewered areas and I/I rates from future sewer construction (see Appendix A). Tables 1 through 3 and Figure 3 show base flow, I/I and total flow projections from 2000 to 2050 using both King County and local agency based base flow projections.

[2] King County population forecasts are based on Puget Sound Regional Council forecasts; local agency population forecasts rely on developers permit applications, recent growth patterns and other information. Wherever possible, the County attempted to rectify its forecasts with those from local agencies. The Task 210 report includes a detailed discussion of population forecasts.

[3] The County's standard wastewater generation rates are 60 gallons per capita per day (gpcd) for residential customers, 35 gpcd for commercial employees and 75 gpcd for industrial employees.

[4] The set of available flow data used to calibrate the I/I model did not include flow monitoring conducted for the Regional I/I Program, because the Regional I/I Program data had not been finalized and published when the CSI South Sammamish Basin flow projections were developed. After the Regional I/I Program data were published in May 2001, King County staff compared I/I model predictions for winter 2000/2001 to the measured flow data. The I/I model predictions closely tracked the observed flow data, providing confidence about the accuracy of the model's prediction of the once per 20 years peak flow. See Appendix A for the figure comparing predicted and observed flow for winter 2000/2001. The South Sammamish Basin predesign team will use the most recent available flow monitoring data when refining the peak flow projections.

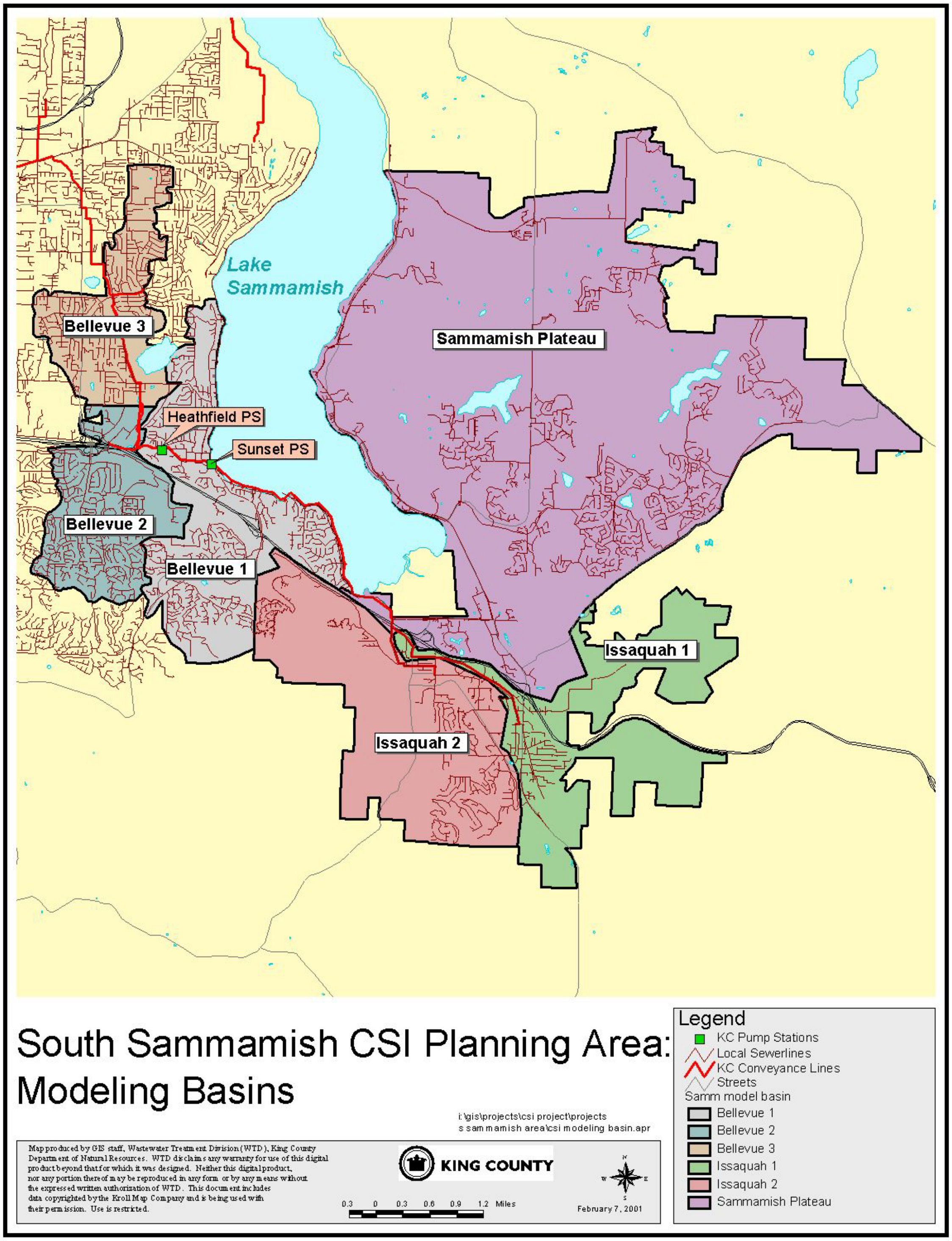


Figure 1. South Sammamish CSI Planning Area Modeling Basins

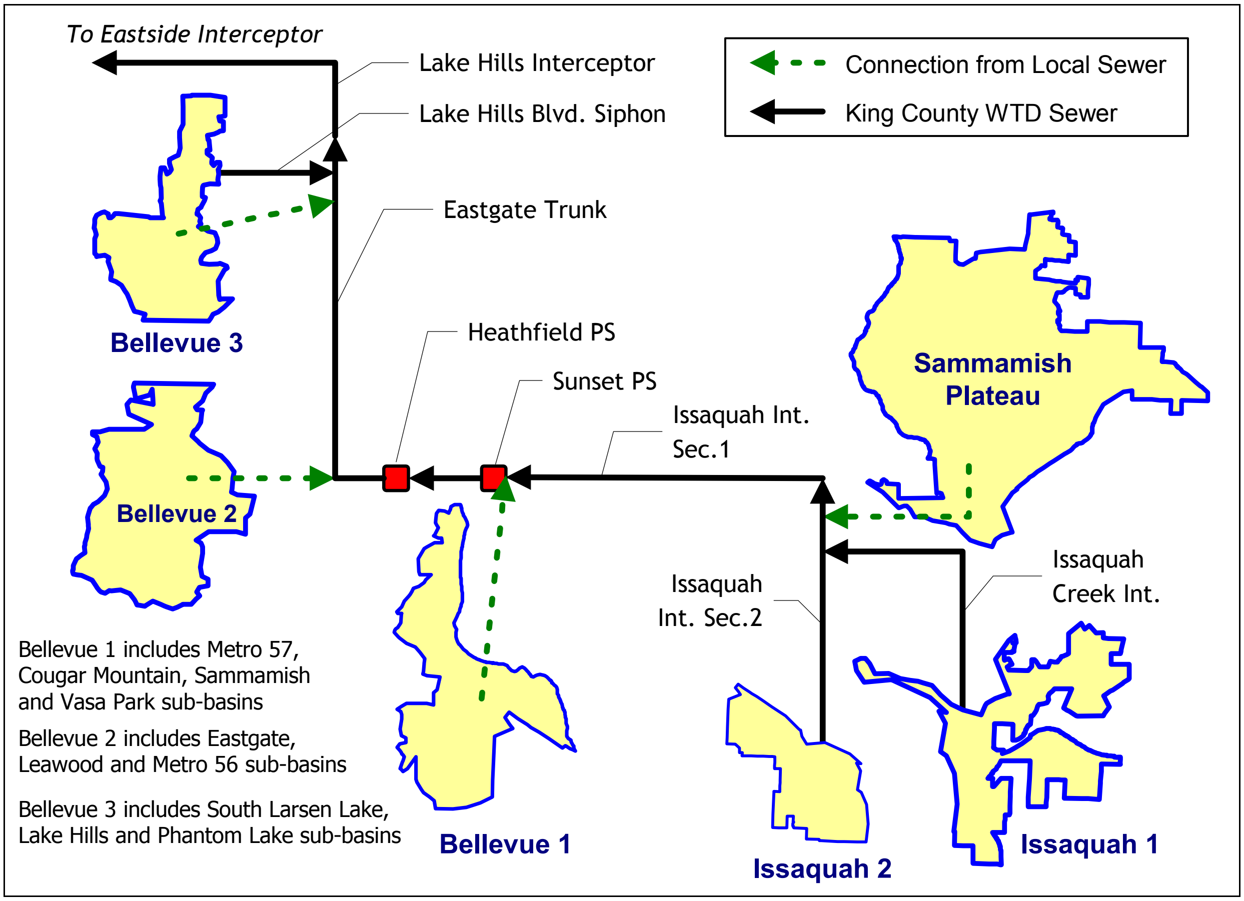


Figure 2. Schematic View of the South Sammamish Basin Conveyance Facilities

Table 1. Projected Peak Flows: Sammamish Plateau

Year	Base Flow (mgd)[1]	Sewered Area (ac)[2]	5yr I/I (gpad)[3]	5yr Peak (mgd)		20yr I/I (gpad)[3]	20yr Peak (mgd)	
				KC[4]	Local[4]		KC[4]	Local[4]
2000	1.93	3,880	900	5.4	5.5	1,100	6.2	6.2
2010	2.52	7,028	1,100	10.2	12.0	1,400	12.4	14.1
2020	3.25	10,175	1,200	15.5	17.9	1,500	18.5	20.9
2030	3.48	10,175	1,200	15.7	18.4	1,600	19.8	22.4
2040	3.78	10,175	1,300	17.0	19.9	1,700	21.1	23.9
2050	4.06	10,175	1,400	18.3	21.4	1,800	22.4	25.4

1. Base flow is calculated from population and employment forecasts, assuming: 60 gallons per capita day (gpcd) residential, 35 gpcd commercial and 75 gpcd industrial. The reported base flows are based on PSRC forecasts.

2. Sewered area estimate based on King County's GIS analysis of basin. Assumes all developable land is sewered by 2020 (see Appendix A).

3. I/I rates are a composite of old and new sewers (see Appendix A). Also includes 7 percent per decade increase in I/I due to effects of sewer aging.

4. KC and Local flows use either KC or local agency population forecasts to estimate the base flow component of peak flow.

Table 2. Projected Peak Flows: Issaquah

Year	Base Flow (mgd)[1]	Sewered Area (ac)[2]	5yr I/I (gpad)[3]	5yr Peak (mgd)		20yr I/I (gpad)[3]	20yr Peak (mgd)	
				KC[4]	Local[4]		KC[4]	Local[4]
Issaquah 1: Drains to Issaquah Creek Interceptor								
2000	0.26	550	3,100	2.0	1.9	3,800	2.4	2.2
2010	0.33	1,165	2,200	2.9	3.2	2,800	3.6	3.7
2020	0.42	1,780	2,000	4.0	4.7	2,500	4.9	5.4
2030	0.45	1,780	2,100	4.2	4.9	2,600	5.1	5.5
2040	0.49	1,780	2,200	4.4	5.3	2,800	5.5	6.0
2050	0.53	1,780	2,300	4.6	5.5	2,900	5.7	6.2
Issaquah 2: Drains to Issaquah Interceptor Section 2								
2000	0.67	1,385	1,600	2.9	2.8	2,100	3.6	3.4
2010	0.80	1,793	1,600	3.7	4.1	2,100	4.6	4.7
2020	0.97	2,200	1,600	4.5	5.3	2,100	5.6	6.2
2030	1.05	2,200	1,700	4.8	5.6	2,300	6.1	6.6
2040	1.15	2,200	1,800	5.1	6.1	2,400	6.4	7.0
2050	1.24	2,200	1,800	5.2	6.1	2,400	6.5	7.0

1. Base flow is calculated from population and employment forecasts, assuming: 60 gallons per capita day (gpcd) residential, 35 gpcd commercial and 75 gpcd industrial. The reported base flows are based on PSRC forecasts.

2. Sewered area estimate based on King County's GIS analysis of basin. Assumes all developable land is sewered by 2020 (see Appendix A).

3. I/I rates are a composite of old and new sewers (see Appendix A). Also includes 7 percent per decade increase in I/I due to effects of sewer aging.

4. KC and Local flows use either KC or local agency population forecasts to estimate the base flow component of peak flow.

Table 3. Projected Peak Flows: Bellevue

Year	Base Flow (mgd)[1]	Sewered Area (ac)[2]	5yr I/I (gpad)[3]	5yr Peak (mgd)[4]	20yr I/I (gpad)[3]	20yr Peak (mgd)[4]
Bellevue 1: Drains to the Sunset Pump Station						
2000	0.95	1,800	1800	4.2	2200	4.9
2010	1.05	2,014	1800	4.7	2300	5.7
2020	1.13	2,228	1900	5.4	2300	6.2
2030	1.17	2,228	2000	5.6	2500	6.7
2040	1.23	2,228	2100	5.9	2600	7.0
2050	1.29	2,228	2100	6.0	2700	7.3
Bellevue 2: Drains to top of Eastgate Trunk						
2000	0.67	2,520	1800	5.2	2200	6.2
2010	0.72	2,595	1900	5.6	2300	6.7
2020	0.74	2,670	2000	6.1	2500	7.4
2030	0.75	2,670	2100	6.4	2600	7.7
2040	0.79	2,670	2300	6.9	2800	8.3
2050	0.82	2,670	2300	7.0	2800	8.3
Bellevue 3: Drains to Eastgate Trunk downstream of Heathfield P.S. force main						
2000	0.83	1,067	1800	2.8	2200	3.2
2010	0.87	1,117	1900	3.0	2300	3.4
2020	0.89	1,167	2000	3.2	2400	3.7
2030	0.90	1,167	2100	3.4	2600	3.9
2040	0.94	1,167	2200	3.5	2700	4.1
2050	0.96	1,167	2200	3.5	2700	4.1

1. Base flow is calculated from population and employment forecasts, assuming: 60 gallons per capita day (gpcd) residential, 35 gpcd commercial and 75 gpcd industrial. The reported base flows are based on PSRC forecasts.

2. Sewered area estimate based on King County's GIS analysis of basin. Assumes all developable land is sewered by 2020 (see Appendix A).

3. I/I rates are a composite of old and new sewers (see Appendix A). Also includes 7 percent per decade increase in I/I due to effects of sewer aging.

4. The projected Bellevue flows do not include separate "KC" and "Local" flows. Local agency and King County/PSRC population were equivalent.

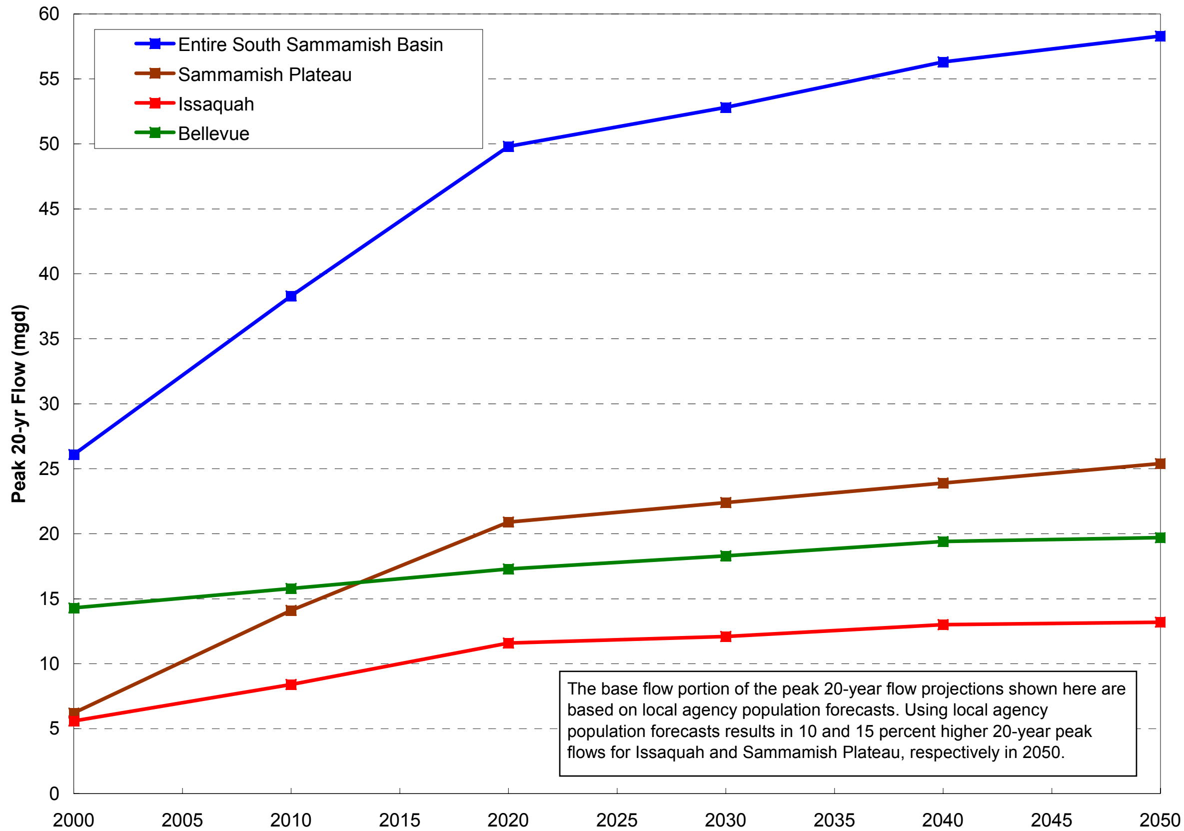


Figure 3. Summary of Flow Projections for the South Sammamish Basin

Allocating Flow to Pipe Sections

This section allocates the flow projections developed above for each of the modeling basins to specific King County WTD facilities, such as pump stations and pipe reaches. The modeling basins are generally defined so wastewater in a basin flows directly one King County conveyance facility. For example, the boundaries of the two Issaquah basins are defined so that Issaquah 1 drains to the Issaquah Creek Interceptor and Issaquah 2 drains to the Issaquah Interceptor. Using GIS data to determine the sewered area draining to particular manholes along a pipeline, the CSI project team estimated the increase in flow along each pipeline. In the next section, the projected flow is compared with conveyance capacity on a manhole-to-manhole basis to determine when and where conveyance facilities will reach their capacity.

Sammamish Plateau Flow Allocation

The entire Sammamish Plateau WSD drains through local sewers to the Issaquah Interceptor Section 2 at manhole R17 –36 (see Task 220). The Sammamish Plateau WSD is planning to increase the capacity of the connecting line, but the discharge location to the County's conveyance system will remain unchanged (see Figure 4).

Issaquah 1 Flow Allocation

Most of Issaquah 1 drains to the top of the Issaquah Creek Interceptor. There are also some additional inputs downstream from commercial sites along Gilman Boulevard. Issaquah 1 is not built out; County projections show an addition of 1,230 sewered acres (roughly a tripling of sewered area) in the next 20 years, much associated with Issaquah Highlands in the east part of the basin.

For this planning-level study, we assumed all the projected 20-year flow from existing local sewers enters the King County system at the top of the Issaquah Creek Interceptor. This is a conservative assumption, designed to avoid underestimating the flow in any reach of the interceptor.

We assumed that flow coming from newly sewered areas would be split: half from Issaquah Highlands in the east part of the basin and half from the upland areas to the south of the Issaquah Creek Interceptor. Issaquah Highlands currently discharges to the Issaquah Creek Interceptor through a local sewer connection at manhole R17-56A; we assumed new development will be served by the same connection. The locations of the other undeveloped parts of the Issaquah 1 basin will probably drain to the top of the Issaquah Creek Interceptor (manhole R17-66) once local sewer infrastructure is in place (see Figure 4).

Table 4. Allocation of Issaquah 1 Modeling Basin Flow

Existing Sewers:
100 percent to Issaquah Creek Interceptor R17-66 (top of interceptor)
Future Development:
50 percent to Issaquah Creek Interceptor R17-56A
50 percent to Issaquah Creek Interceptor R17-66 (top of interceptor)

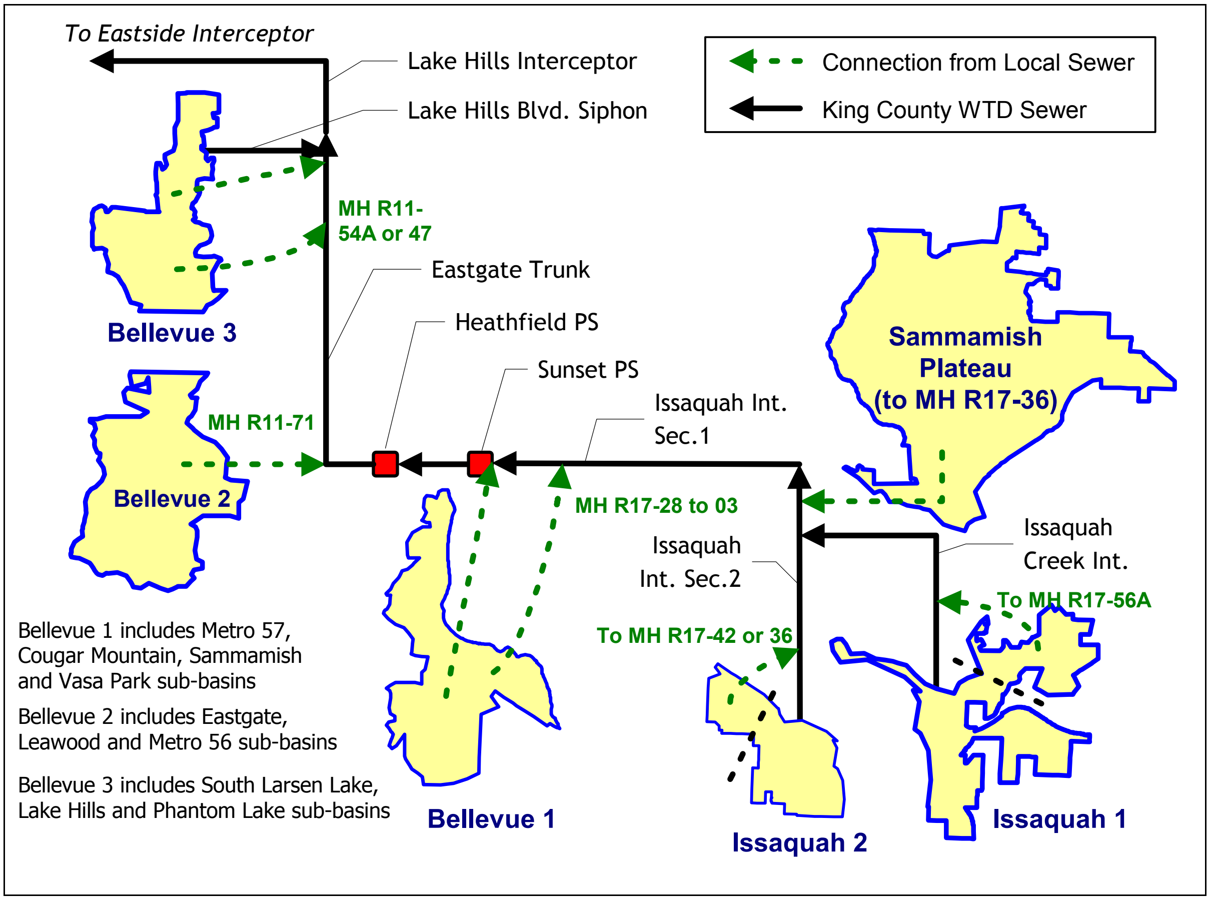


Figure 4. Schematic Allocation of Modeling Basin Flow to Conveyance Facilities

Issaquah 2 Flow Allocation

The local sewers in the Issaquah 2 basin drain mostly to the top of the Issaquah Interceptor Section 2, although some local sewers also connect at manholes R17-36 and R17-42 (see Figure 4). Future expansion of sewered areas will be concentrated in the east part of the basin. The largest planned development for this basin is East Village, which will connect at manhole R17-51. Basin topography suggests that other new developments in the east part of the basin will probably connect to the King County system near manhole R17-42.

For this planning-level study, we used GIS software and information about future development provided the City of Issaquah Public Works to allocate Issaquah 2 flow to specific segments of the Issaquah Interceptor. Approximately 110 sewered acres presently drain to manhole R17-42, and 40 acres drain to manhole R17-36. The remainder of the basin enters at or near the top of the interceptor. Since future development is concentrated in the east part of the basin, we assumed 50 percent of the new sewered area will drain to manhole R17-42, and 50 percent will connect to the Issaquah Interceptor at manhole R17-49.

Table 5. Allocation of Issaquah 2 Modeling Basin Flow

Existing Sewers:
89 percent to Issaquah Interceptor R17-51 (top of interceptor)
8 percent to Issaquah Interceptor R17-42
3 percent to Issaquah Interceptor R17-36
Future Development:
50 percent to Issaquah Interceptor R17-42
50 percent to Issaquah Interceptor R17-51

Bellevue 1 Flow Allocation

The Bellevue 1 basin drains to the Sunset Pump Station from the north, south and west. About 25 percent of the basin's flow enters the Issaquah Interceptor through local sewer connections in Lake Sammamish. The remainder of the wastewater enters the County's conveyance system at the pump station. Slow growth is forecasted within this basin. We assumed that future flows will be allocated in the same proportions as current flows: 25 percent entering the Issaquah Interceptor between R17-28 and R17-03, and 75 percent entering at the Sunset Pump Station (see Figure 4).

Bellevue 2 Flow Allocation

The entire Bellevue 2 basin links through local sewers to the top of the Eastgate Trunk at manhole R11-71.

Bellevue 3 Flow Allocation

The Bellevue 3 basin includes connections to the Eastgate Trunk, Lake Hills Boulevard Siphon and the Lake Hills Interceptor. Using GIS analysis, the basin was sub-divided into four separate zones that drain to specific manholes (see Figure 4). Because only limited growth is forecasted in Bellevue 3, it is assumed that allocation of flows will remain consistent throughout the study's planning window.

Table 6. Allocation of Bellevue 3 Modeling Basin flow

Connection to KC sewer	Percentage of Bellevue 3 Sewered Area
Eastgate Trunk, MH R11-54A	10
Eastgate Trunk, MH R11-47	7
Top of Lake Hills Boulevard Siphon	40
Top of Lake Hills Interceptor	43
Bellevue 3 area (2000) = 1,067 ac	
Bellevue 3 area (2050) = 1,167 ac	

Facility Capacity Overview

Comparing the projected future peak flows to the existing capacity of the wastewater conveyance system is a necessary first step in determining what improvements will be required in the South Sammamish Basin. Using the flow allocation described in the previous section, the 20-year peak flow in the Issaquah Creek Interceptor, Issaquah Interceptor, and Eastgate Trunk is plotted over the pipeline capacities that were calculated and presented in the Task 220 report (Figures 5 to 8). Figure 9 shows a schematic summary of the facility capacity analysis.

Figure 5 shows the Issaquah Creek Interceptor presently has sufficient capacity for the 20-year peak flow, but by 2010, the pipeline will surcharge at manhole R17-47A. By 2020, the peak 20-year flow will be greater than the conveyance capacity in most of the pipeline.

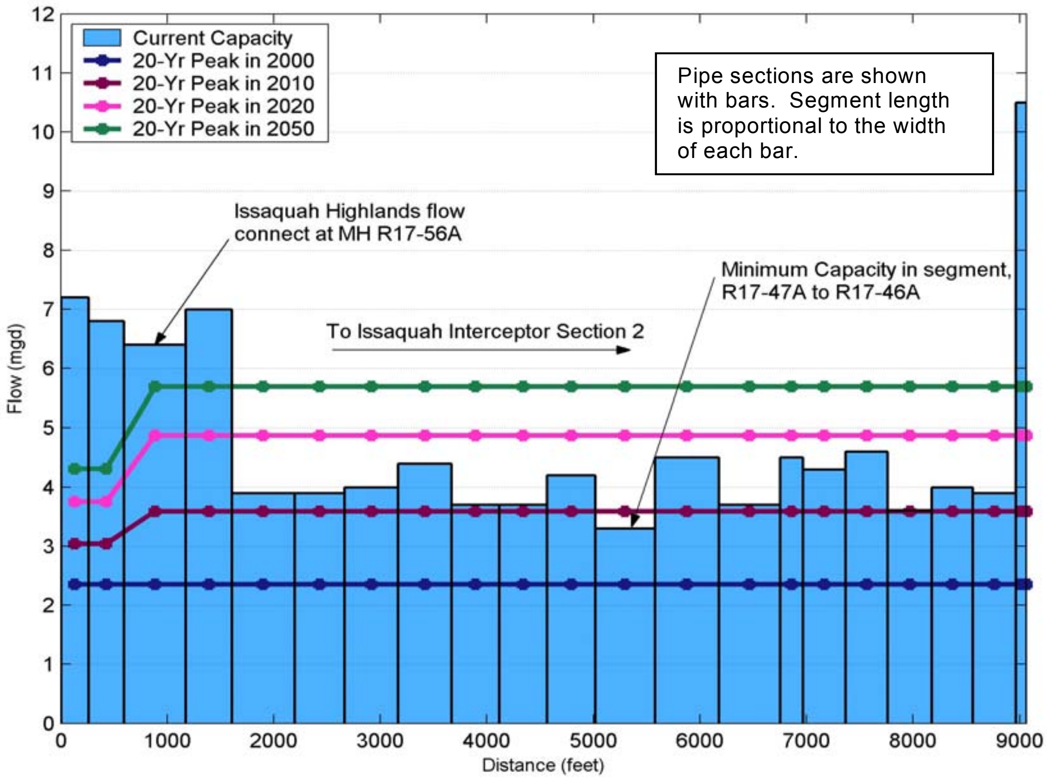


Figure 5. Issaquah Creek Interceptor: Full-Pipe Capacity and 20-Year Peak Flow

Figure 6 shows capacity and peak flow in the Issaquah Interceptor Section 2, which is aligned through downtown Issaquah before accepting flow from the Issaquah Creek Interceptor and the Sammamish Plateau. The pipeline has enough capacity through 2010, but several sections will be beyond their capacities by 2020.

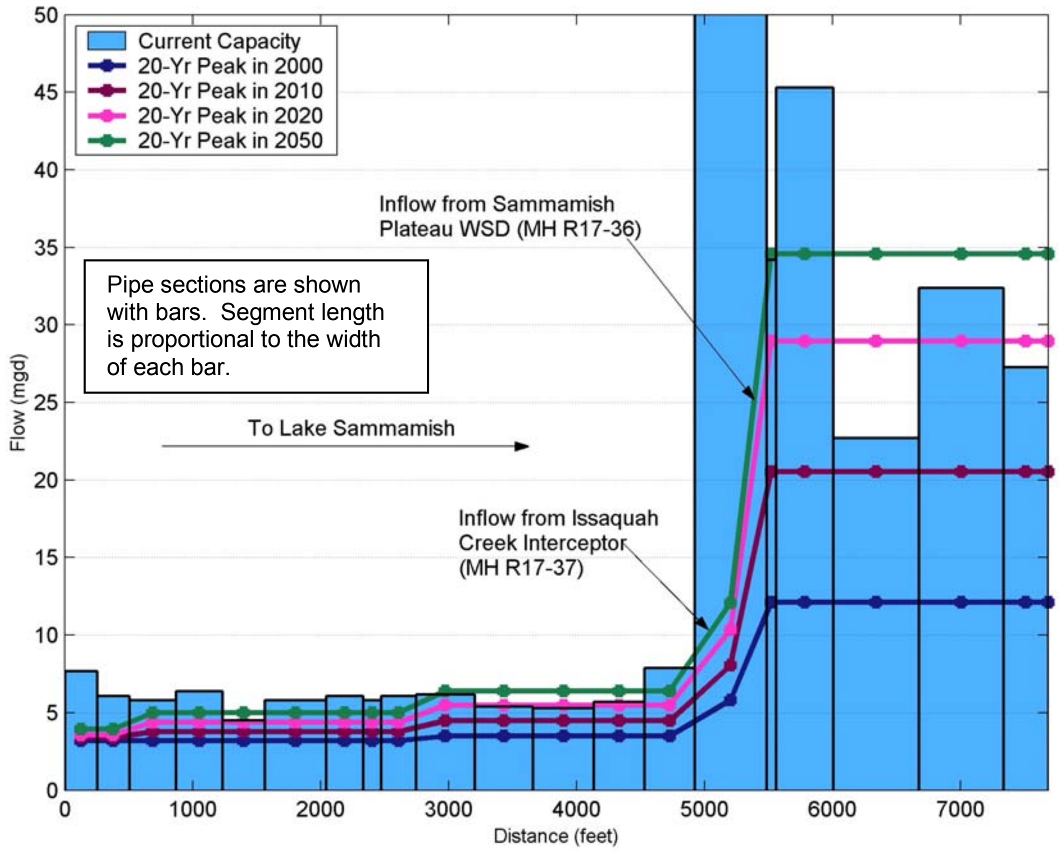


Figure 6. Issaquah Interceptor Sec. 2: Full-Pipe Capacity and 20-Year Peak Flow

The Issaquah Interceptor Section 1, which is aligned from the south end of Lake Sammamish to the Sunset Pump Station, is shown in Figure 7. The pipeline is 48 inches in diameter and relatively flat because it was constructed within Lake Sammamish, giving it a consistent full-pipe capacity.

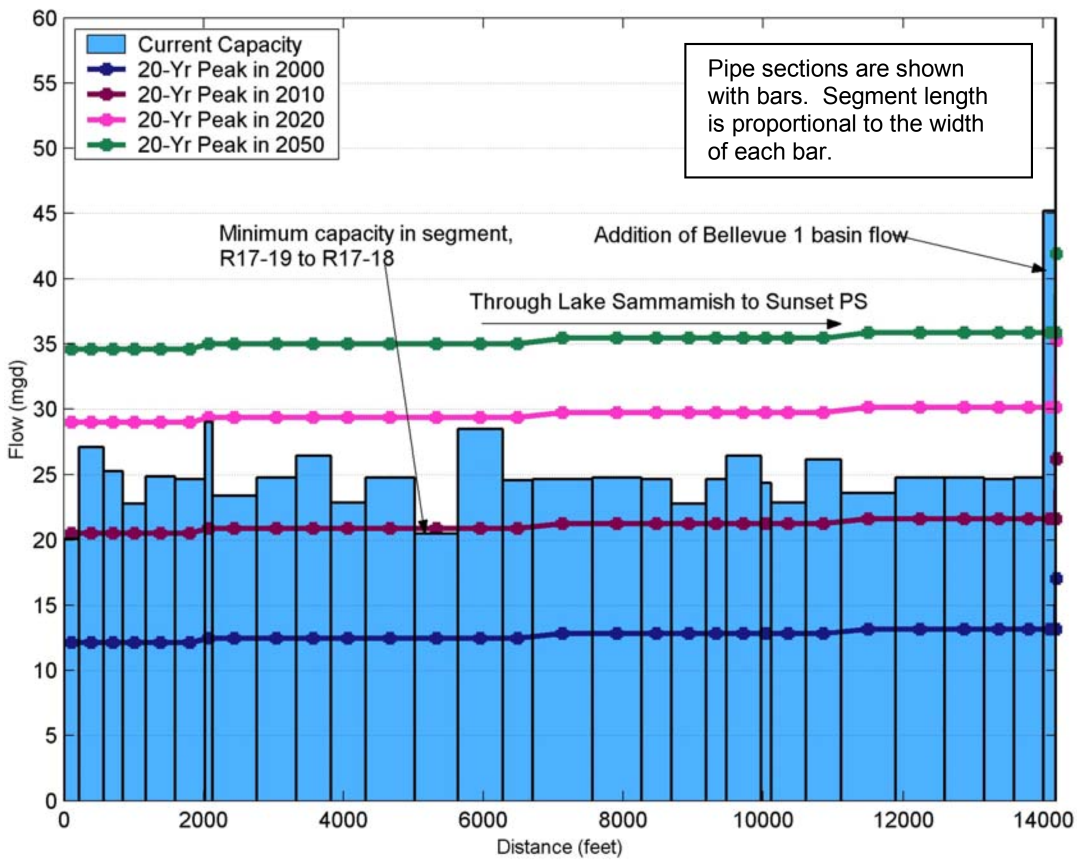


Figure 7. Issaquah Interceptor Sec. 1: Full-Pipe Capacity and 20-Year Peak Flow

The jump of approximately 5 mgd at the end of the Issaquah Interceptor is due to the addition of flow from the Bellevue 1 modeling basin at the Sunset Pump Station. By 2010, flow at the pump station will exceed the 18 mgd capacities of both the Sunset and Heathfield Pump Stations[5], even though the Issaquah Interceptor Section 1 will be within its capacity.

[5] King County WTD staff ran a maximum flow test in October 2001 that estimated the maximum pumping rate of the Sunset Pump Station is 18 mgd. Note: this value is lower than the 24 mgd capacity given in the *King County Off Site Facilities Manual*.

The Eastgate Trunk conveys flows from parts of Bellevue as well as all of the flow in King County facilities that serve Issaquah and the Sammamish Plateau. The upstream end of the Eastgate Trunk contains discharge from the Bellevue 2 modeling basin. At Manhole R11-67, the trunk expands to two parallel lines and adds flow from the Heathfield Pump Station force mains. If all upstream facilities are upgraded to convey the 20-year peak flow, sections of the Eastgate Trunk will be over-capacity by 2010 (Figure 8).

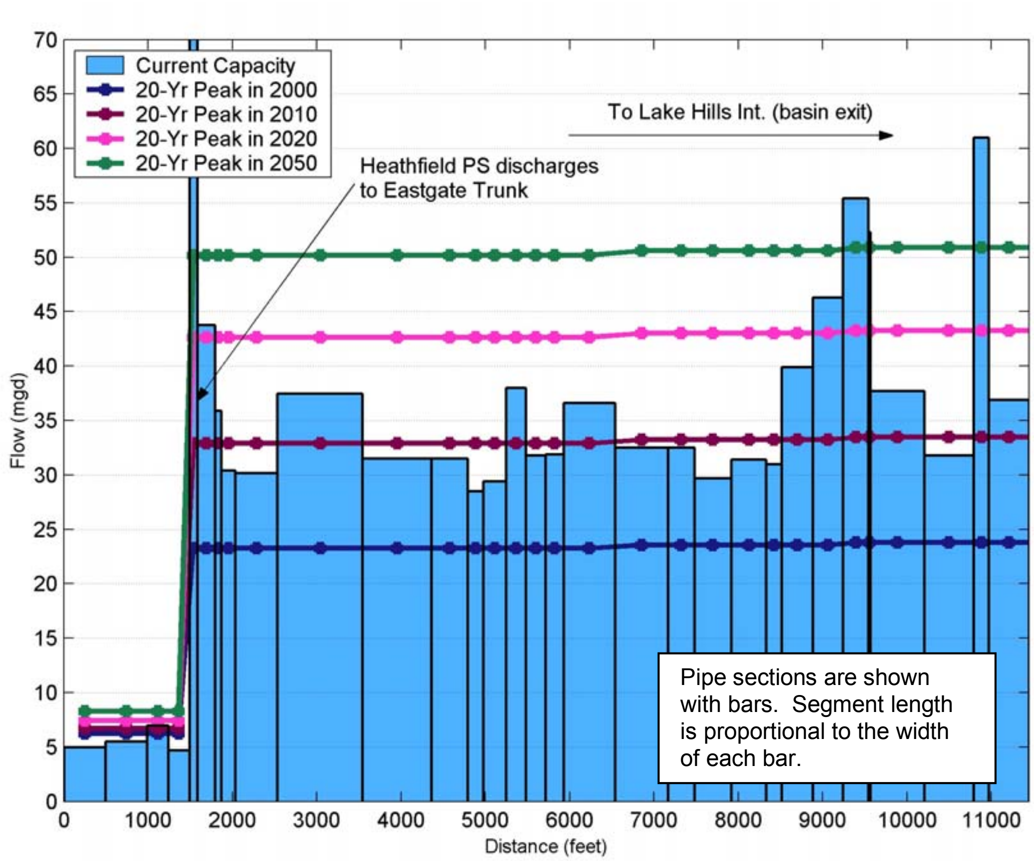


Figure 8. Eastgate Trunk: Full-Pipe Capacity and 20-Year Peak Flow

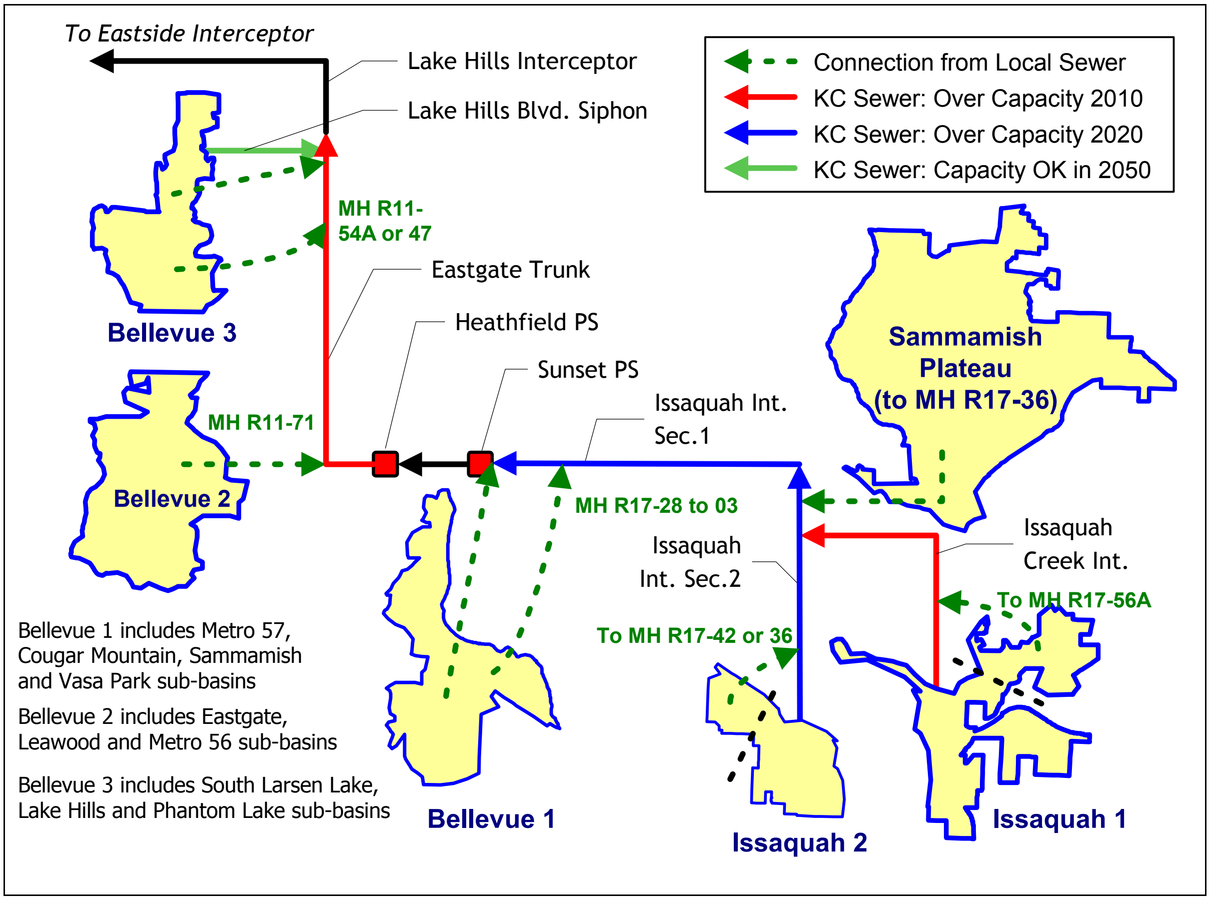


Figure 9. Summary of Capacity Overview for South Sammamish Basin Facilities

The conveyance capacity charts above showed projected peak flows and King County facility capacities throughout the South Sammamish Basin. The County's existing facilities have enough capacity to convey the peak 20-year flow at present, but as development progresses, system improvements will be necessary to continue to meet the King County SSO standard. The following list summarizes when conveyance facilities will be beyond their capacities:

1. Issaquah Creek Interceptor will begin to experience localized capacity problems in 2010 and widespread capacity limitations in 2020 as development in Issaquah proceeds

2. By 2020, the Issaquah Interceptor Sections 1 and 2 will not have enough capacity to convey the peak 20-year storm

3. The Sunset and Heathfield Pump Stations will be at capacity by 2010

4. The Eastgate Trunk will be beyond its capacity by 2010

5. The Lake Hills Boulevard Siphon (see Task 220) has enough capacity to convey Bellevue 3 modeling basin flows through 2050

Most of the growth of peak flow in the next several decades is projected to occur in the upper part of the basin, in Issaquah and the Sammamish Plateau. Wastewater improvement alternatives that increase the conveyance capacity along the existing route would have the effect of transferring capacity problems downstream. For example, capacity upgrades to the Issaquah Creek and Issaquah Interceptors would increase capacity shortfalls at the Sunset and Heathfield Pump Stations. Upgrading the pump stations would require upgrades along the Eastgate Trunk. However, the sequential upsizing/paralleling of existing facilities can be avoided through a program that involves selected capacity upgrades, flow diversions and demand management.

DEVELOPMENT OF CONVEYANCE SYSTEM IMPROVEMENT ALTERNATIVES

This section provides an overview of various approaches to reducing the frequency of conveyance system overflows to once per 20 years through 2050. These approaches are organized into three general categories: increased conveyance capacity, flow management, and flow diversion.

Each of the alternative components listed in Table 7 is analyzed in the following section, based on available information. The analyses address the replacement, upgrading and/or construction of new KC facilities, construction factors, planning and permitting issues[6], planning level costs and impacts on other KC WTD facilities. The individual alternatives are not conceived as comprehensive solutions to all conveyance problems in the South Sammamish Basin. However, when alternatives are combined as necessary into package solutions, they can provide a flexible and comprehensive plan for managing conveyance issues. This report contains a detailed description and analysis of each alternative; the Task 250 report includes various packaging options and the results of the County's decision workshop.

[6] Planning and permitting issues, as well as environmental considerations are examined in the Task 250 report.

Table 7. CSI Alternatives for the South Sammamish Basin

Alt.	Category	Alternative Description	How it helps
A	Diversion	Diverting a portion of the Sammamish Plateau north to the NE Sammamish Interceptor	• Reduces flow to downstream facilities
B	Diversion	Diverting wastewater away from Sunset PS, north along the west side of Lake Sammamish to the Lake Hills Trunk	• Reduces flow to Sunset and Heathfield PS and Eastgate Trunk
C	Flow Mgmt.	Using storage tanks or tunnels to attenuate peak flows	• Reduces peak flow downstream of storage
D	Diversion/ Capacity	Divert flow along the I-90 right-of-way to the Eastside Interceptor	• Reduces flow to Sunset and Heathfield PS and Eastgate Trunk • Provides relief to Factoria Interceptor
E	Diversion/ Capacity	Construct a land-based sewer to bypass Issaquah Interceptor Section 1 (lake line)	• Increases capacity between Issaquah and Sunset PS • Reduces reliance on in-lake sewer line
F	Capacity	Increase capacity of Sunset and Heathfield Pump Stations and Eastgate Trunk	• Removes bottleneck in Bellevue part of basin
G	Flow Mgmt.	Targeted I/I reduction in coordination with the County's regional I/I program	• Reduces flow to downstream facilities
H	Flow Mgmt.	Reclaimed water production and discharge in the basin	• Reduces flow to downstream facilities
I	Diversion	Reroute the Issaquah Highlands drainage away from the Issaquah Creek Interceptor	• Reduces flow to facility that would be beyond capacity in 2010 and is located in heavily commercial ROW

The planning level cost estimates shown in this section utilize a common set of assumptions for input into the Tabula cost estimating model. Table 8 lists the assumptions used for each alternative.

Table 8. Cost Estimate Development Assumptions

Item	Assumption
Total Dynamic Head (TDH)	Maximum TDH per single-stage pump station is 200 feet. In certain instances where the required TDH would slightly exceed 200 feet, we deviated from this assumption to avoid an additional pump station. Where the required TDH would be between 240 feet and 340 feet, it was assumed that a two-stage pump station would be used rather than 2 separate single-stage pump stations. It was assumed that a two-stage pump station would cost 75% more than a single-stage pump station to account for additional pumps, controls and building area.
Pipeline Sizing	Pipes were sized to maintain a velocity from 2 to 8 ft/s throughout the full range of pump station operation.
Alternative Installation Methods	Where gravity sewer and force main pipelines depths would exceed 25 feet, pipeline installation was assumed to be by alternative tunneling methods (microtunneling and horizontal directional drilling (HDD)). Microtunnel shaft spacing was set at approximately 1,500 feet.
Cost Estimate: Cost were estimated using King County developed cost estimating software, Tabula (version 1.0)	Unless otherwise specified in the alternative description text, the following assumptions were made within Tabula: • Seattle ENR-CCI of 7,341 • Public rights-of-way and easements would be used (i.e. no cost for easement or right-of-way acquisition) • Existing utilities would be “average” complexity • Traffic would be “heavy” • Manhole spacing would be average (500 feet) for gravity sewer pipelines • Pavement restoration would be required for a 14-foot width (equivalent to half width of a residential street) for pipelines installed using conventional cut-and-cover techniques • Gravity sewer cover depth would be 12 feet and force main cover depth would be 8 feet • Trench backfill would be “imported” • Dewatering would be “minimal” • Trench safety would be “standard” • Pump excavation depth would be 20 feet • Mobilization/demobilization is 10 percent add-on to construction cost NOTE: Costs do not include KC allied costs or contingencies.

Alternative A: Diverting a Portion of the Sammamish Plateau North to the NE Sammamish Interceptor

Diverting a portion of the Sammamish Plateau Water and Sewer District's (WSD) present and/or future wastewater flow northward to the NE Sammamish Interceptor would provide relief to over-capacity facilities throughout the South Sammamish Basin. The topography of the Sammamish Plateau and the pattern of development have led to a drainage pattern that generally sends flow to the west, across the plateau, then down steeper slopes towards the lake. At East Lake Sammamish Parkway, wastewater is directed south towards Lake Sammamish State Park and the Issaquah Interceptor. The following discussion will address locations for the diversion, conveyance options (e.g. one pump station, a series of pump stations, or pressures gravity sewer), facility sizes and alignments, and environmental and permitting issues.

Location of Flow Diversion

The location and volume of the diversion should strike a balance among reducing flow to downstream South Sammamish Basin facilities, limiting construction cost per gallon diverted, and not overwhelming the capacity of the NE Sammamish Interceptor and its downstream facilities. While developing a complete solution for managing South Sammamish Basin wastewater is an iterative and ongoing process, there are three diversion locations that appear feasible (Figure 10):

1. *Inglewood Hills Road.* Diverting north at the intersection of Inglewood Hills Road and East Lake Sammamish Parkway. The existing local sewer flows off the Plateau under enough pressure to convey wastewater 3.5 miles to the NE Lake Sammamish Interceptor by gravity.

2. *Lift Station S-10 North.* This diversion location would collect and pump wastewater from the S-10 Lift Station back to Inglewood Hills Road and northward to the NE Lake Sammamish Interceptor. There is a small number of connections between Inglewood Hills Road and S-10 North.

3. *Lift Station S-10 South.* This diversion would capture the greatest flow, but would also require the most pumping and highest construction costs.

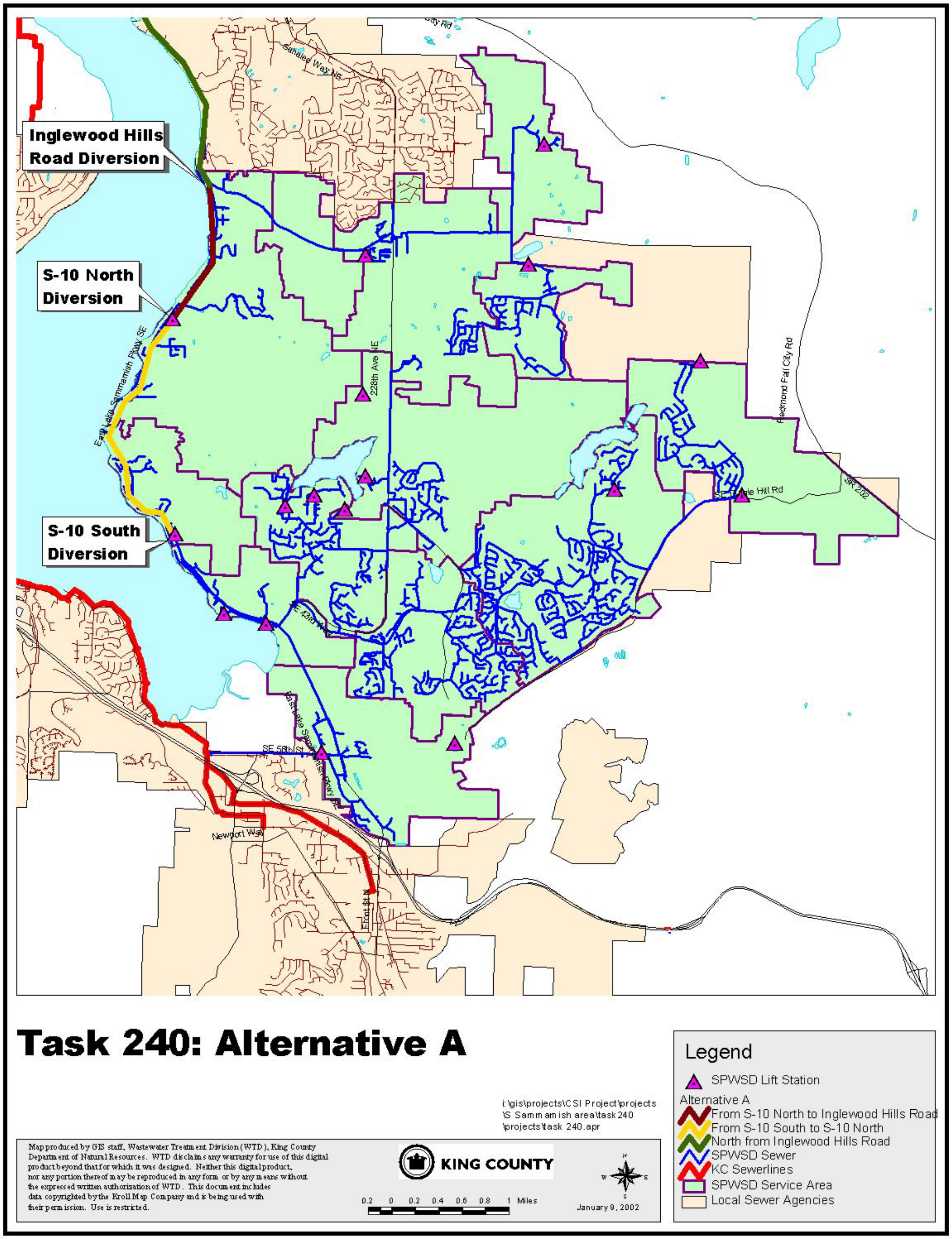


Figure 10. Sammamish Plateau Diversion to the NE Sammamish Interceptor

Size of Flow Diversion

It is important to determine how much flow could be diverted from each of three identified locations, so as to compare costs with flow diverted and to determine whether downstream facilities would require additional capacity. The flow projections in Table 9 show the base flow and peak 20-year flow for 2005 (the earliest probably construction date) and 2050. The calculations are based on the Sammamish Plateau WSD population forecasts for each of the sub-basins and King County WTD I/I projections.

Table 9. Projected Peak Flows for the Alternative A Diversions

Diversion	SPWSD Basins	Year	Base Flow (mgd)	20yr Peak (mgd)
Inglewood Hills Road	Tiburon, Inglewood East, Beaver Dam, NE Plateau	2005	0.45	1.94
		2050	0.88	4.87
Lift Station S-10 North	*Same as Inglewood Hills Road Diversion* + ½ North Lake Sammamish	2005	0.50	2.41
		2050	1.11	6.23
Lift Station S-10 South	*Same as Inglewood Hills Road Diversion* + All of North Lake Sammamish	2005	0.55	2.88
		2050	1.34	7.59

Like the Sammamish Plateau, the NE Sammamish will experience higher wastewater flow in the future. Figure 11 shows the full-pipe conveyance capacity of the NE Sammamish Interceptor as well as projected 20-year peak flow from the NE Sammamish basin[7]. If additional flow is transferred to the NE Sammamish basin from Carnation, these transferred flows must also be considered when determining remaining pipe capacity.

Figure 11 shows the interceptor has enough excess capacity to accommodate any of the three diversion levels through 2030, the last year for which flow projections were available. Alternative A would reduce the number of upgrades required in the South Sammamish Basin. Directing flows north would also give King County staff flexibility to send part of the South Sammamish Basin wastewater to either the South Treatment Plant or the future Brightwater Treatment Plant.

[7] The NE Sammamish peak flow projections are derived from the SNOFLO spreadsheet of modeling results that were prepared by the Wastewater Treatment Division's modeling group for the *RWSP*. At present, these are the best flow projections available for the area. When additional information becomes available through future CSI and regional I/I program work, revised flow projections should be incorporated.

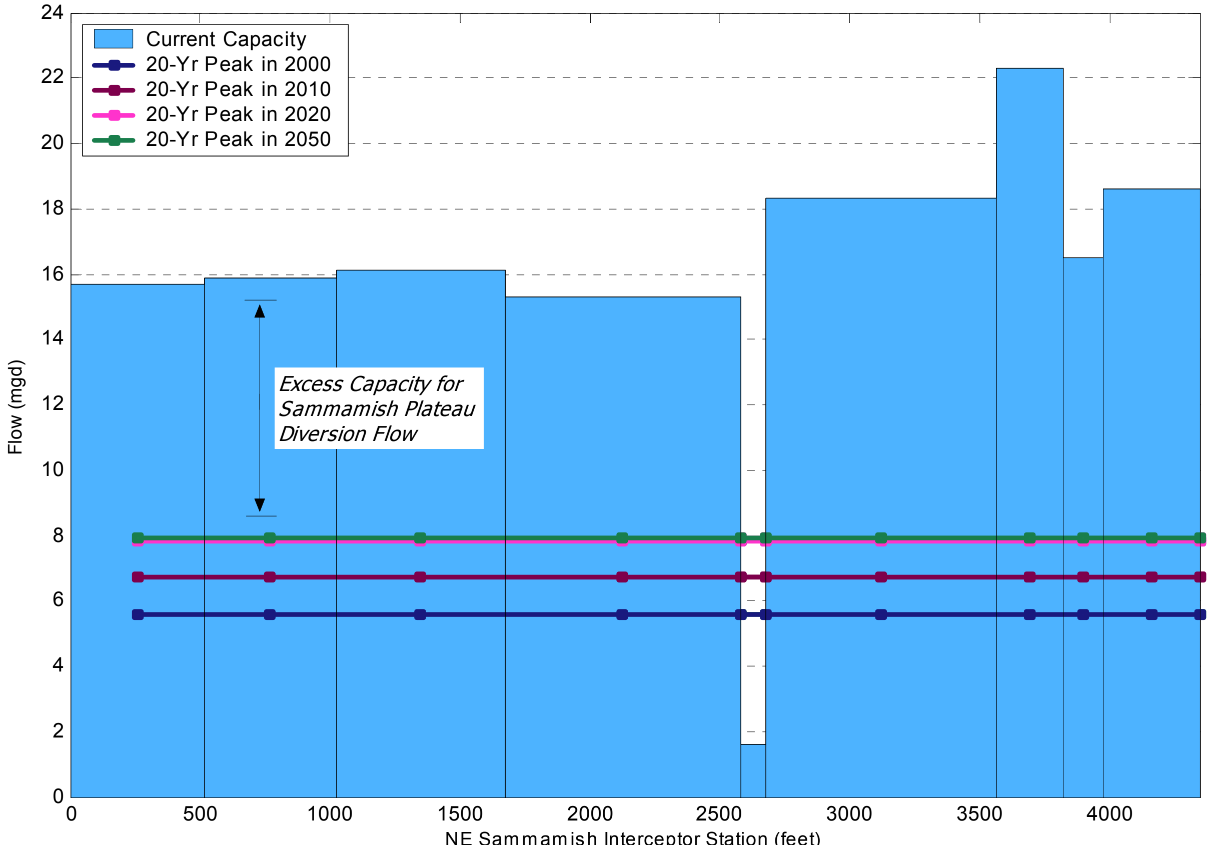


Figure 11. Projected Peak Flow and Capacity in NE Sammamish Interceptor

Project Scheduling and Construction Factors

City of Sammamish staff has indicated that Sammamish plans to improve East Lake Sammamish Parkway to conform to the city's arterial standard. The plan includes the following improvements:

- Widening East Lake Sammamish Parkway to three lanes: one lane in each direction with the center lane containing either a turn pocket or a planted median
- Five foot bike lanes in each direction. The bike lanes will be included regardless of the construction and route of the East Lake Sammamish Trail.
- Planting strips and sidewalks on both sides of the street

The project will probably be constructed in phases, with phase 1 focusing from Inglewood Hills Road to the north. Sammamish hopes to proceed with construction in 3 to 4 years, but the project does not have funding yet. The proposed schedule would provide an opportunity for coincident construction with the CSI project. City of Sammamish staff indicated the City would be amenable to joint construction and noted that Sammamish would require a 5-year no 'tear-up' period after a new roadway is built.

Based on this conversation, the planning level construction costs for Alternative A assume the diversion alignment would be in East Lake Sammamish Parkway. However, the costs estimates use standard Tabula projections, without including a potential savings through coincident construction with City of Sammamish. Refined cost estimates prepared during design should reflect any collaboration between King County and the City of Sammamish. Also, Sammamish Plateau WSD owns lift stations, pressure and gravity sewers along East Lake Sammamish Parkway that could be transferred to King County WTD if the S-10 North or S-10 South diversion routes are pursued. The CSI project team and King County staff can investigate the hydraulic issues related to reversing the direction of the S-10 North and S-10 South Lift Stations in Task 250.

Table 10 lists the information used to develop the Alternative A cost estimate. Cost estimate assumes the utilities along East Lake Sammamish Parkway would be "complex".

Table 10. Alternative A Cost Estimates

	Diversion Point		
	Inglewood[1] Hills Road	Lift Station[2] S-10 North	Lift Station[3] S-10 South
Year 2050 Flow, mgd	4.87	6.23	7.59
Gravity Sewer Diameter, in	24	27	30
Gravity Sewer Length, ft	18,500	18,500	18,500
Force Main Diameter, in	N/A	18	20
Force Main Length, ft	N/A	6,600	18,200
Pump Station #1 TDH, ft	N/A	105	105
Pump Station #2 TDH, ft	N/A	N/A	200
Year 2001 Capital Construction Costs	**$8.6M**	**$13.7M**	**$22.7M**
Cost per Gallon Diverted	**$1.77**	**$2.20**	**$3.00**

1Assumes gravity sewer flow from Inglewood Hills Road to NE Sammamish Interceptor.

2Assumes flow pumped from new pump station at S-10 North lift station through force main to Inglewood Hills Road area where it would flow by gravity to NE Sammamish Interceptor.

3Assumes flow pumped from new pump station at S-10 South lift station through force main to second new pump station at S-10 North lift station. Second new pump station would then pump flow through force main to Inglewood Hills Road area where it would flow by gravity to NE Sammamish Interceptor.

Alternative B: Diverting Wastewater Away from the Sunset Pump Station Force Main, North to the Lake Hills Trunk

Similar to Alternative A, this alternative would divert wastewater northward along the west shore of Lake Sammamish and out of the basin. In this case, the diversion would occur in the vicinity of the Sunset Pump Station and take advantage of existing roadways to reach the Lake Hills Trunk in the Hol-Hills basin. The total length of the diversion, as shown in Figure 12, would be 25,500 lineal feet. (The Lake Hills Trunk should not be confused with the Lake Hills Interceptor, which conveys South Lake Sammamish basin wastewater to the Eastside Interceptor). This diversion would also require a new pump station approximately 2.5 miles downstream from Sunset Pump Station.

This diversion only provides relief for facilities downstream of the Sunset Pump Station and is contingent on the availability of excess capacity in the Lake Hills Trunk. Alternative B would have to be paired with other alternatives that could control upstream flows. Previous King County modeling work and operations experience suggest there are capacity limitations in the Lake Hills Trunk. Providing upgrades to the Lake Hills Trunk would increase the cost of this alternative, but these upgrades could be viewed as a regional benefit that will be required regardless of the CSI South Sammamish project.

Table 11 summarizes the information used to develop the cost estimate. Upgrades to the Lake Hills Trunk are not included in this cost estimate.

Table 11 Alternative B Cost Estimate

	Low Range	High Range
Flow, mgd	4	14
Force Main Diameter, in	14	24
Force Main Length, ft	20,900	20,900
Sunset Pump Station TDH (2-stage required), ft	380	330
Year 2001 Capital Construction Costs	**$10.9M**	**$16.8M**

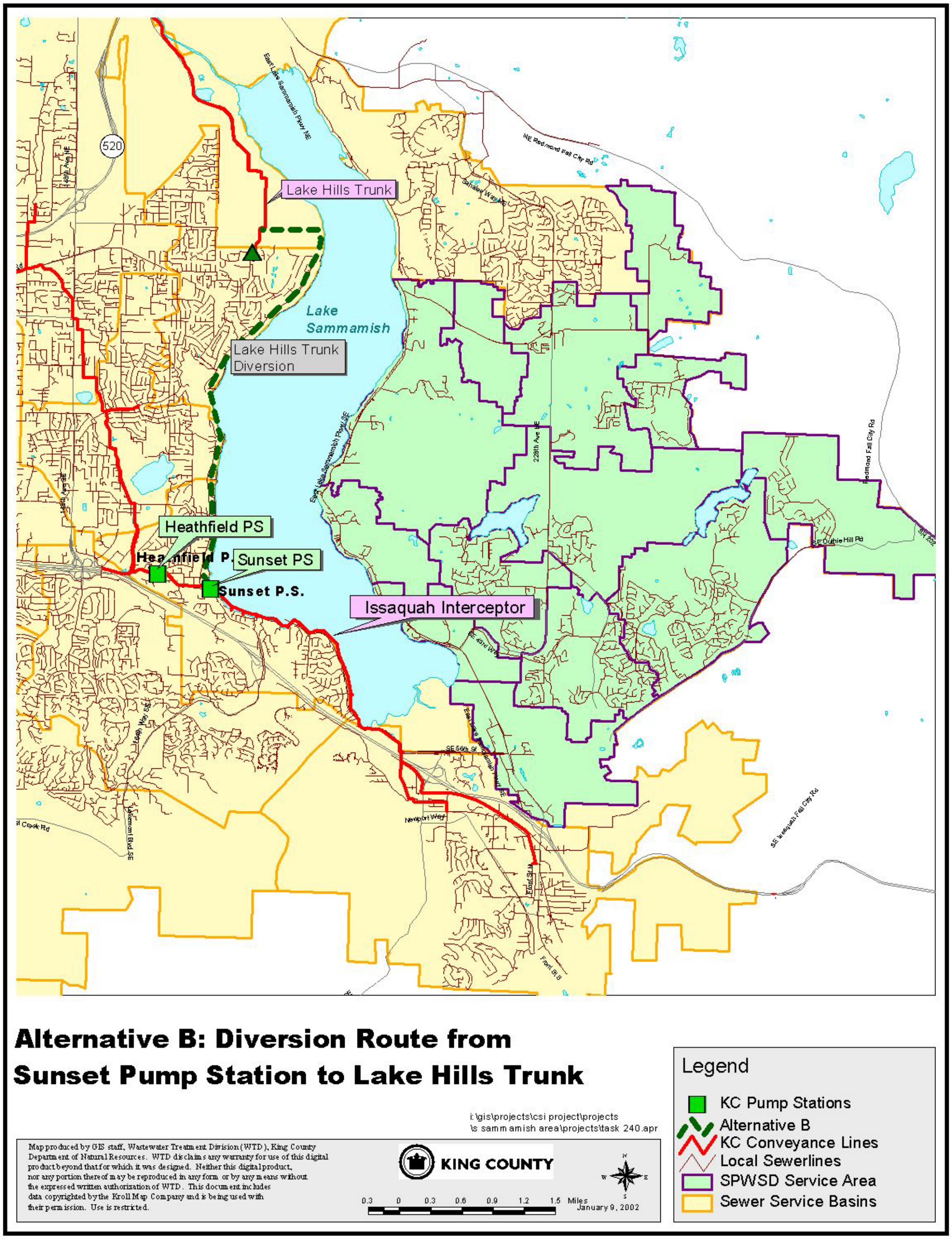


Figure 12. Diversion Route from Sunset Pump Station to Lake Hills Trunk

Alternative C: Using Storage Tanks or Tunnels to Attenuate Peak Flow

Storage facilities can be incorporated into the wastewater conveyance system to manage peak wet weather flows that would otherwise produce SSOs. When the existing pipes and pump stations have enough capacity for wastewater flows, the storage facilities would not be used. Storage facilities can be arranged in a number of ways, from a single large tank to a series of wide pipe sections for distributed storage. Where space is tight, tunnels may be a better option than tanks, because tunnels can be constructed in existing street right-of-way, limiting property acquisition needs.

Operation and maintenance have traditionally been concerns for storage facilities due to detectable odors near the storage site and the necessity for workers to wash down storage facilities after use. In the CSI project, we would site storage facilities for gravity in/out flow whenever possible and suggest self-cleaning devices be added to minimize operation and maintenance issues. In the Task 240 report, the analysis is limited to size and preliminary/ general locations for storage facilities. After the analysis of various packaging options for the alternatives, if storage forms a part of the Working Alternative, the Task 250 report will evaluate site-specific construction factors.

The most serious bottleneck in the South Sammamish Basin occurs where the Issaquah Interceptor, Issaquah Creek Interceptor, and Sammamish Plateau WSD flows come together. Upstream of the bottleneck would be an effective area for storage facilities. Figure 13 shows possible locations for storage facilities.

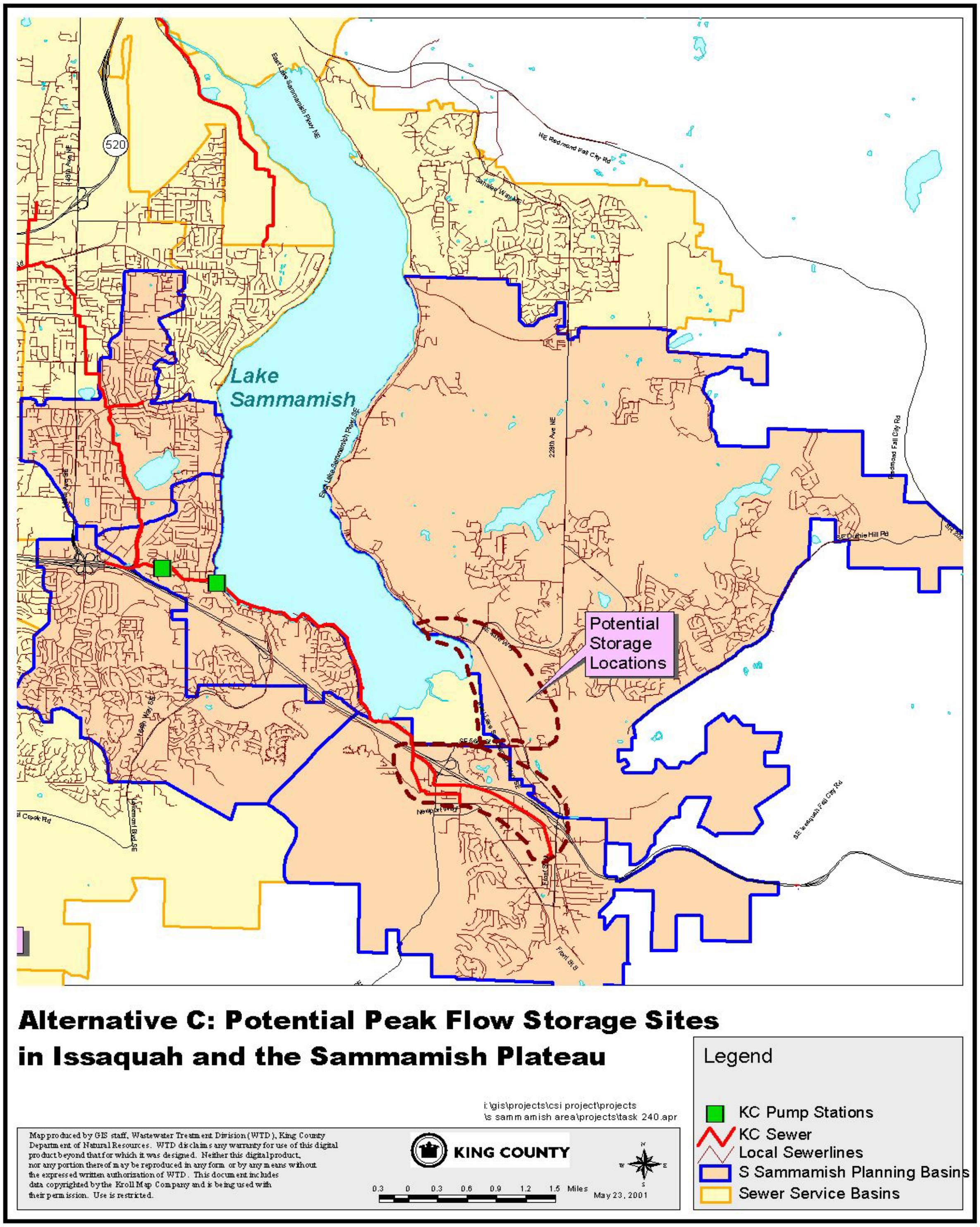


Figure 13. Potential Peak Flow Storage Sites

The amount of flow reduction downstream of a storage facility is not a simple, linear function of the storage volume. The downstream conveyance capacity, and the magnitude and duration of the peak flow events all affect the efficiency of storage facilities. Typically, storage is most effective in basins with high I/I responses, although storage also can be useful for lower I/I basins, such as the Sammamish Plateau. Figures 14 and 15 give a nomographic view of the relationship between storage volume and flow reduction for a peak 20-year flow in Issaquah and the Sammamish Plateau.

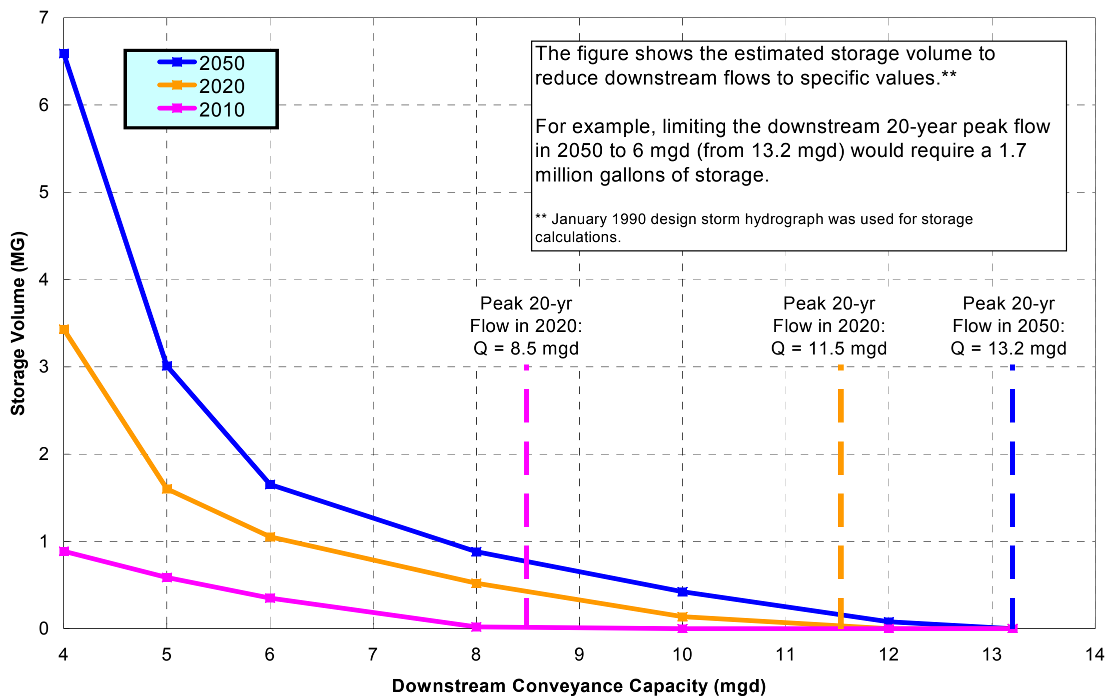


Figure 14. Issaquah: Required Storage Volume to Limit Downstream Flow

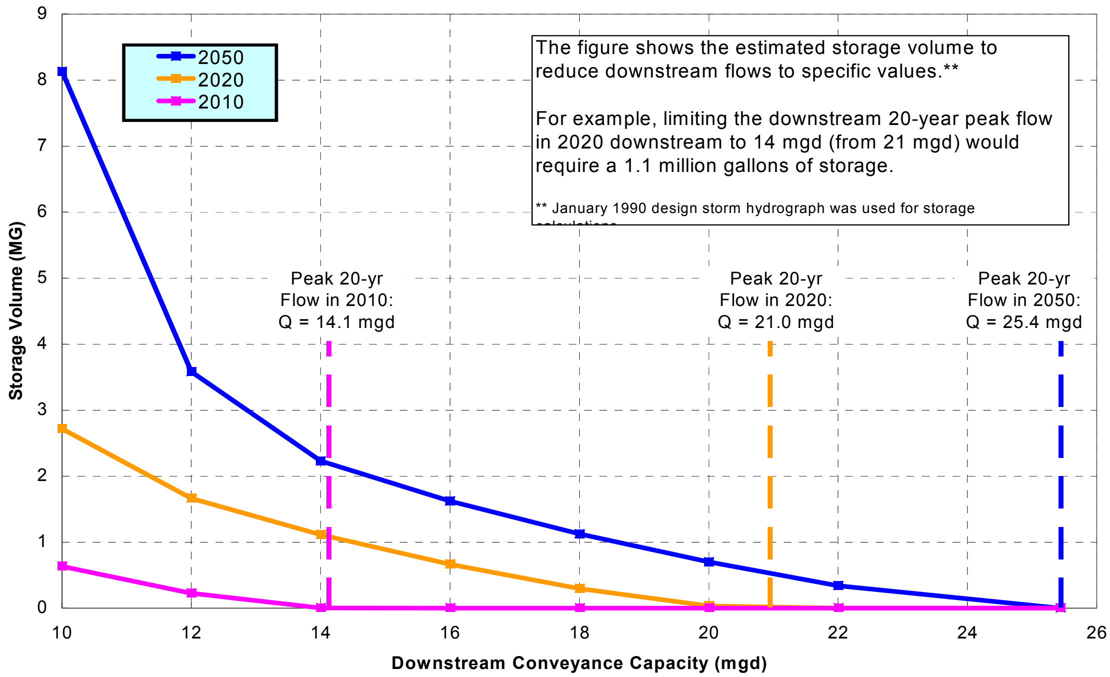


Figure 15. Sammamish Plateau: Required Storage Volume to Limit Downstream Flow

Peak flow storage is a flexible alternative that could form a part of the wastewater management solution for the South Sammamish Basin. The size, location and phasing of storage facilities can be incorporated into packaged alternatives in a variety of ways depending on the desired flow reduction. Ultimately, the application of storage in the South Sammamish Basin should be evaluated on the basis of cost relative to other alternatives and operation and maintenance considerations.

The potential cost range for the Alternative C was developed by estimating costs for a 2 MG underground storage tank and a 2 MG storage tunnel. For cost estimating purposes, the following assumptions were used:

Storage Tunnel:

- A 12-foot tunnel diameter to facilitate tunnel construction.
- Significant dewatering required.
- Storage tunnel cost estimated as a bypass storage facility.

Storage Tank:

- Significant dewatering and land acquisition would be required due to the potential storage tank location on the south end of Lake Sammamish where high groundwater conditions are likely to be found.

- Storage tank depth of 15 feet.

- Gravity in/out flow storage tank configuration.
- Land acquisition required for "office/commercial" type property.

Based on these assumptions, the potential storage tunnel cost is $10M and the potential storage tank cost is $16.3M.

Alternative D: Divert flow along the I-90 right-of-way to the Eastside Interceptor

This alternative would route a combination of force main and gravity piping in the large right-of-way adjacent to I-90, diverting flow from the Eastgate Trunk by conveying South Sammamish Basin wastewater directly to the Eastside Interceptor. A new pump station would send flow to the ridge top at the west edge of the basin. At the ridge top, flow would transition to gravity, flowing through the Factoria basin to the Eastside Interceptor.

The new gravity line could be sized to accept flow from local Bellevue sewers in the Factoria basin as topography would allow. However, intercepting flow directly from the Factoria trunk is not feasible for two reasons: 1) according to King County Operation and Maintenance staff, the invert elevation of the top of the Factoria Trunk line is less than the invert elevation of ESI Section 8 near the I-405 and I-90 interchange and 2) the Factoria trunk flows by gravity to the north, away from where the new gravity line would be located.

Based on conversations with Washington Department of Transportation (WSDOT) staff the following considerations would be required in order to construct a pipeline in the I-90 right-of-way.

- There are numerous utilities along the I-90 right-of-way making the corridor very crowded.
- A Franchiser Permit would be required. The permit takes 12 weeks for WSDOT to process and typically 2 months for federal agencies to approve. It is recommended that a meeting be held with WSDOT prior to applying for the permit.
- I-90 is a limited access facility and is only under the stewardship of WSDOT. No utilities can be placed in the limited access unless they are installed with a boring. The boring pits are not allowed in the right-of-way. If the utility must be installed with open trench or the boring pit must be in the right-of-way, then a variance is required.

The CSI project team identified two starting points for the I-90 diversion, referred to as Alternatives D1 and D2, and shown in Figure 16. Alternative D1 would bypass the lake line portion of the Issaquah Interceptor. Alternative D2 would begin at the upstream end of the Eastgate Trunk. Both of the alternatives would have the same discharge location, the Eastside Interceptor Section 8.

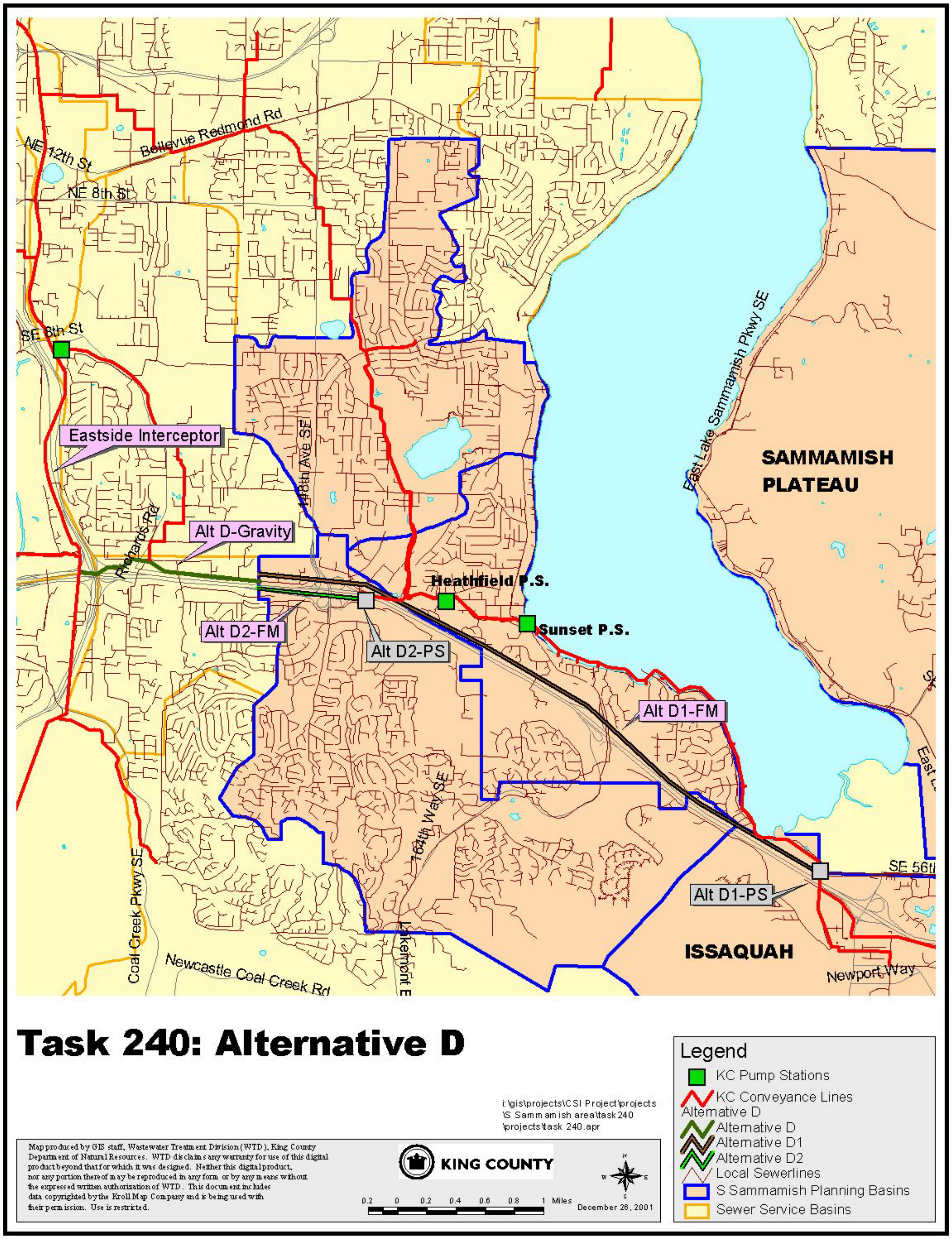


Figure 16. Alternatives D1 and D2. Diversion Along the I-90 Right-of-Way

Alternative D1: Divert at Lake Sammamish State Park

Alternative D1 would build a pump station and force main near the southeast corner of Lake Sammamish State Park, drawing wastewater from the Issaquah Interceptor between Manholes R17-36 and R17-34. This location includes all flows from Issaquah and the Sammamish Plateau and is immediately upstream of the Issaquah Interceptor Section 1 (lake line). Section 1 of the Issaquah Interceptor is a system bottleneck that will not have adequate capacity in 2020. A second pump station would be required to achieve the TDH required to reach the downstream gravity section. The capacity of the pump stations and force mains could range up to 14 mgd to prevent overflows in downstream sections of the Issaquah Interceptor. If I/I control, peak flow storage and/or flow diversion is used upstream of this location, the size of the pump stations and force mains could be reduced in proportion to the upstream flow reduction. The length of diversion piping would be 17,500 lineal feet of force main, and 12,000 lineal feet of microtunnel to tunnel under major road crossings and along the I-90 right-of-way.

The construction of the pump stations and force mains could be delayed until capacity limitations make them necessary (projected to be between 2010 and 2020). The pump stations should be sized and operated to eliminate downstream conveyance problems in extreme wet weather conditions, and to permit adequate flow velocities to prevent solids deposition and odors in the Issaquah Interceptor during low flow periods and normal operation of the Sunset and Heathfield Pump Stations. Table 12 shows key flow rates for the year 2010 that help demonstrate how the Alternative D1 pump stations would be operated.

Table 12. Key Flow Rates for Alternative D1 Diversion

Base Flow:	2010	2020	2050
Sammamish Plateau	2.5 mgd	3.2 mgd	4.1 mgd
Issaquah	1.1 mgd	1.4 mgd	1.8 mgd
Total Base Flow	3.6 mgd	4.6 mgd	5.8 mgd
Average Dry Weather Flow [A]	4.7 mgd	5.8 mgd	7.1 mgd
Average Wet Weather Flow [A]	6.2 mgd	7.3 mgd	8.9 mgd
5-year Peak Flow	16.8 mgd	23.9 mgd	28.1 mgd
20-year Peak Flow	20.5 mgd	29.0 mgd	34.6 mgd

A. ADW I/I = 107 gpad and AWW I/I = 257 gpad in 2010. Rates in 2020 and 2050 are 7 and 21 percent higher, respectively. Source: RWSP and CSI modeling.

To determine how the pump stations could be operated, examine:

A) The average and peak wet weather flows to set the minimum frequency of operation

B) The average dry weather flow to see how dry weather operation would affect minimum velocities in existing facilities.

Comparing the average wet weather flow values in the table above to the Issaquah Interceptor's hydraulic capacity (Figure 7) shows that the existing facilities have sufficient capacity for average wet weather flows throughout the planning period. That means the diversion pump stations would be required to prevent overflows only during large storms, probably a few times per winter.

If the diversion pump stations are only operated during large storms, they will not have an impact on odor generation in the existing piping during the dry season. The pump stations should include flushing equipment to limit odors in the periods when the pump stations go unused. If more frequent operation is desired, the CSI project team or the predesign team should construct a hydraulic model of the Issaquah Interceptor Section 1 to determine how much flow can be removed from the line during dry weather while maintaining minimum flow velocities.

Construction Factors

This section identifies major construction factors associated with Alternative D1. The Task 250 report will address specific construction factors.

- The pump station that would be located at the SE corner of Lake Sammamish would be in a lowland area with high groundwater. It is also near Tibbetts Creek. If this alternative receives further consideration in Task 250, the report should include a map of the Tibbetts Creek 100-year flood plain

- As discussed in the Alternative D section, King County would have to obtain an easement along the I-90 right-of-way for the force main. If the force main were routed through the open area adjacent to the freeway, surface repaving would not be required

- The force main would navigate large freeway interchanges at Lakemont Boulevard/Lake Sammamish Parkway SE, 148th Avenue SE (Eastgate Interchange) and I-405. Trenchless construction methods, such as directional drilling would be necessary near the interchanges

Table 13 summarizes the information used to develop the Alternative D1 cost estimate. The cost estimate is based on the following assumptions within Tabula:

- No pavement restoration would be required.

- Due to the potential high groundwater, $1M was added to the pump station cost for high groundwater mitigation.

- Existing utilities along I-90 would be "complex".

Table 13. Alternative D1 Cost Estimate Summary

	Low Range	High Range
Flow, mgd	4	14
Force Main Diameter, in	14	24
Force Main Length, ft	17,500	17,500
Microtunnel Diameter, in	15	24
Microtunnel Length, in	12,000	12,000
Pump Station #1 TDH, ft	225	205
Pump Station #2 TDH, ft	240	230
Year 2001 Capital Construction Costs	**$20.7M**	**$30.0M**

Alternative D2: Divert at Top of Eastgate Trunk

Alternative D2 would collect wastewater at the top of the Eastgate Trunk (near I-90, east of the Eastgate Interchange) and flow westward to Eastside Interceptor Section 8. The length of diversion piping would be 12,200 lineal feet of microtunnel to tunnel underneath major road crossings and along the I-90 right-of-way. Alternatively, a pump station and conventional cut and cover techniques could be implemented, but congested utilities may be a concern.

The new gravity pipe would be sized to convey all Bellevue 2 modeling basin flow. According to King County flow projections (see Table 3), the 20-year peak flow will range from the present rate of 6.2 mgd to 8.3 mgd in 2050. The base flow will range from 0.7 to 0.8 mgd throughout the planning period. The gravity pipe should include an extra 2 mgd of capacity for local flows in the Factoria sewer basin.

This alternative is an effective method to reduce flows to the Eastgate Trunk, but requires upstream flow management to address other capacity needs in the basin. Its advantages over Alternative D1 are the shorter pipe length and no pump station . Alternative D2 provides benefits to the Factoria basin by reducing flow to the Factoria Trunk, and is less likely to be perceived as simply a large-pipe solution

Table 14 summarizes the information used to develop the Alternative D2 cost estimate.

Table 14. Alternative D2 Cost Estimate Summary

	Low Range	High Range
Flow, mgd	8.2	10.3
Microtunnel Diameter, in	15	24
Microtunnel Length, ft	12,600	12,600
Year 2001 Capital Construction Costs	**$8.7M**	**$10.8M**

Alternative E: Construct a Land-Based Sewer to Bypass Issaquah Interceptor Section 1

The construction of a land-based sewer to bypass the Issaquah Interceptor Section 1 would aid wastewater conveyance in two ways:

1. It would reduce the risk (seismic and otherwise) associated with having a 40 year old sewer operating within Lake Sammamish. As Issaquah and the Sammamish Plateau grow, the Issaquah Interceptor Section 1 will convey more wastewater, making the consequences of pipe failure more serious. The Issaquah Interceptor Section 1 is scheduled to receive a seismic, risk assessment as part of the CSI project; the results of the assessment will be incorporated into the wastewater management solution for the basin. Based on conversations with King County Operations and Maintenance staff, Issaquah Interceptor Section 1 is experiencing deterioration of its pilings and shoring within Lake Sammamish.

2. A new, higher capacity sewer could alleviate the conveyance bottleneck at the south end of Lake Sammamish. However, increasing the capacity between Lake Sammamish State Park and the Sunset Pump Station would simply transfer conveyance problems downstream. The additional capacity would only be a benefit, if other alternatives, such as downstream storage or the Lake Hills Trunk Diversion (Alternative B), were also constructed.

If a land-based replacement is built, one issue that must be addressed is how service will be provided to the homes located close to Lake Sammamish. Many of these homes are located downhill of any likely routing for a land-based pipe. If future service for homes close to the lake is provided by the existing lake line, slow flow velocities and summertime odors could be a concern. If these homes are rerouted to the replacement piping, project cost estimates must be revised by the design team to include the necessary modifications to the local wastewater drainage.

The length of piping would be 6,900 lineal feet of force main and 5,300 lineal feet of gravity sewer. One pump station would be required to bypass the Issaquah Interceptor Section 1 and would be located at the SE corner of Lake Sammamish in a lowland area with high groundwater.

Table 15 summarizes the information used to develop the Alternative E cost estimate. The cost estimate includes an additional $1M for the pump station cost to account for potential high ground water mitigation.

Table 15. Alternative E Cost Estimate Summary

	Low Range	High Range
Flow, mgd	4	14
Force Main Diameter, in	14	24
Force Main Length, ft	6,900	6,900
Gravity Sewer Diameter, in	12	21
Gravity Sewer Length, ft	5,300	5,300
Pump Station TDH, ft	235	220
Year 2001 Capital Construction Costs	**$7.3M**	**$10.8M**

Alternative F: Increase capacity of Sunset and Heathfield Pump Stations and Eastgate Trunk

Similar to Issaquah Interceptor Section 1, the Sunset and Heathfield Pump Stations and the Eastgate Trunk will be over-capacity in the coming decades unless a way is found to manage and reduce wet weather flows upstream. According to King County, the actual capacity of the Sunset and Heathfield Pump Stations is 18 mgd. If upstream facilities continue to convey all flows to the two pump stations, more capacity will be necessary. This alternative would involve construction of pump station upgrades at Sunset and Heathfield Pump Stations and 5,700 lineal feet of force main and 8,100 lineal feet of gravity sewer in the Eastgate Trunk right-of-way (Figure 17).

A major drawback to increasing conveyance of the Eastgate Trunk is that the existing utilities are congested. Between manholes R11-58 and R11-48, there are three sewer pipes running in parallel: two Eastgate Trunk and one Bellevue sewer. Additionally, adding sufficient capacity (up to 18 mgd extra) to the Sunset and Heathfield Pump Stations/Eastgate Trunk corridor could introduce capacity-related problems to the Lake Hills Interceptor, which begins at the outlet of the South Sammamish Basin.

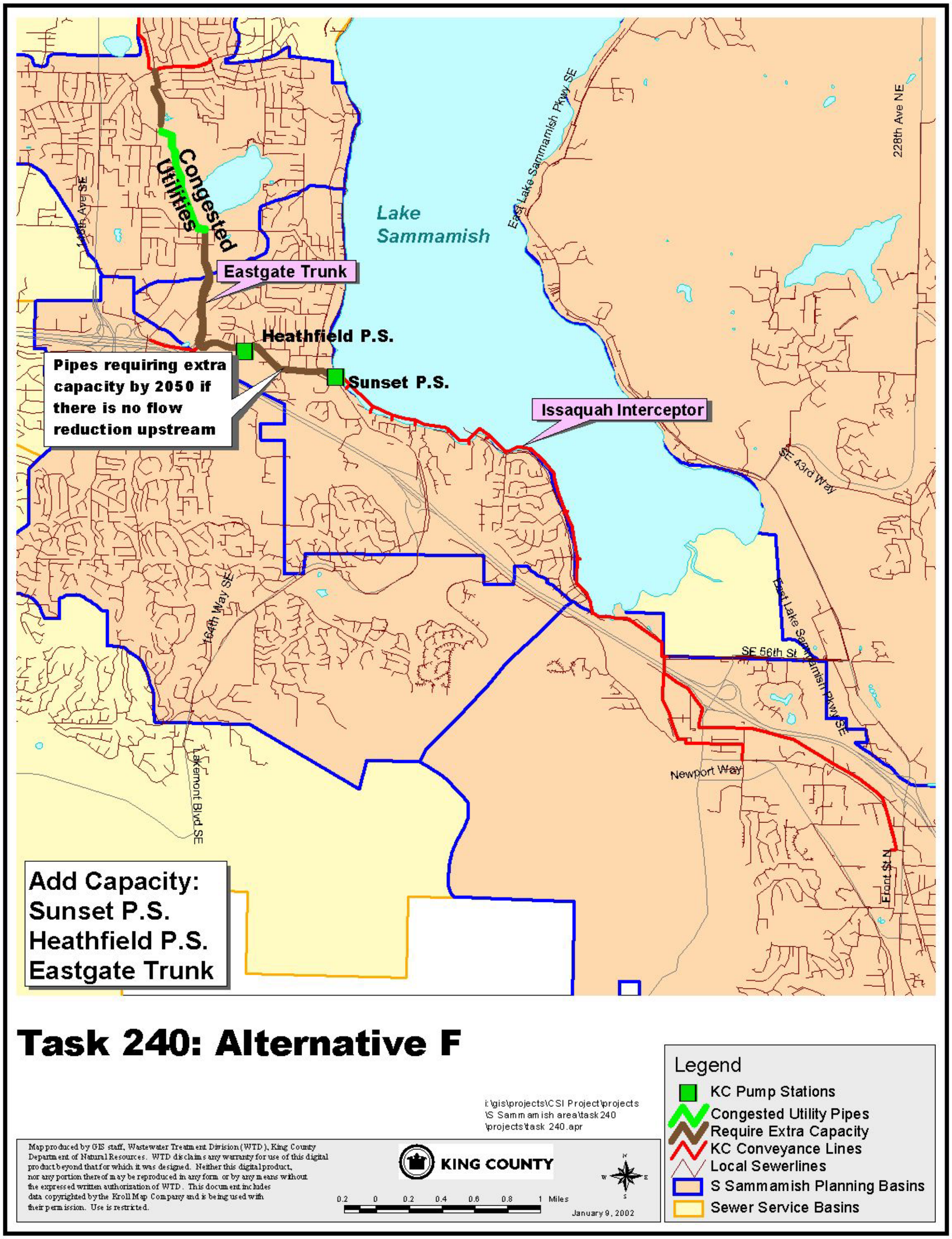


Figure 17. Increase Capacity in Existing Right-of-Way

Table 16 summarizes the information used to develop the Alternative F cost estimate. The cost estimate is based on the following assumptions:

- The cost for upgrading Heathfield and Sunset pump stations would be equivalent to new pump stations. To account for potential high groundwater near the Sunset pump station, $1M was added to the pump station cost.
- Existing utilities would be "complex".
- To achieve the required flow capacity, the existing force mains (12-inch and 24-inch) from Sunset and Heathfield pump station would need to upsized. The force main diameter shown in Table 16 is the diameter that would replace the existing 12-inch force main to achieve the required flow capacity.

To account for Bellevue 1 basin flow entering upstream of Sunset Pump Station, the low flow range was set at 5 mgd. The high range flow was set at the amount that Eastgate Trunk is projected to be over capacity (see Figure 8).

Table 16. Alternative F Cost Estimate Summary

	Low Range	High Range
Flow, mgd	5	18
Force Main Diameter, in	20	30
Force Main Length, ft	5,700	5,700
Gravity Sewer Diameter, in	18	30
Gravity Sewer Diameter, ft	8,100	8,100
Sunset Pump Station #2 TDH, ft	180	170
Heathfield Pump Station #2 TDH, ft	230	220
Year 2001 Capital Construction Costs	**$11.7M**	**$19.6M**

Alternative G: Flow Management through I/I Control in Coordination with the County's Regional I/I Program

With its location near the outer edge of the County's conveyance system, South Sammamish Basin wastewater travels 16 to 25 miles through numerous conveyance facilities before reaching the South Treatment Plant in Renton. Wet weather flows in the basin combine with wet weather flows from other basins and add to the peak conveyance managed by the County. Reducing the amount of I/I in the conveyance system can help avoid or delay capital projects for increased capacity, and reducing I/I can also help reduce stress and provide operational flexibility downstream in the conveyance system.

Flow management through I/I control can take two forms in the South Sammamish Basin:

1. Reducing I/I through a program of targeted sewer rehabilitation. Targeted I/I reduction would focus on areas of the local collection system that have high I/I rates that drain to a conveyance facility that is near its capacity. The following section discusses the Regional I/I Control Program results for winter 2000/2001 and identifies the minibasins that have high I/I rates.

2. Enforcing construction standards and using programmatic collection system maintenance to limit I/I. Given the large amount of growth and sewer expansion forecasted in Issaquah and the Sammamish Plateau in the next two decades, King County could realize a significant system-wide benefit if local sewers are constructed to ensure low I/I rates. Flow monitoring conducted in 2000 showed that the Sammamish Plateau WSD sewers, which are mostly less than 10 years old, admit only a small amount of I/I.

The costs associated with I/I removal are site specific, generally ranging from $2 to $12 per gallon per day of the peak 20-year flow removed. I/I removal is most likely to be cost effective in the South Sammamish Basin where a small reduction in flow could avoid a costly facility upgrade. The area tributary to the Issaquah Creek Interceptor may be one such area.

The following section presents information contained in the *2000/2001 Wet Weather Flow Monitoring Technical Memorandum* (2000/2001 WWTM), dated May 2001. The discussion and graphics (Figure 18 to Figure 23) help illustrate the variation in I/I rates throughout the South Sammamish Basin and identify where targeted I/I reduction is most feasible. The alternative packaging options developed for the Task 250 report will incorporate the Regional I/I Program data and analysis to help develop target I/I reduction volumes and costs.

Regional I/I Control Program

King County has initiated a multi-year effort to determine the wet weather performance and geographic distribution of I/I throughout its collection system. The results within the South Sammamish Basin are presented here. The year 2000/2001 wet season was abnormally dry and only four rain events produced observable system-wide responses. Table 17 (Table A1 from the 2000/2001 WWTM) presents the range of rainfall over the entire service area for the four rain events.

Table 17. Range of Rainfall for Four Events over Entire System

Date of Rain Event	Rainfall (inches)	Rainfall Event Frequency[A]
November 7, 2000	0.7 – 1.3	< 2 year
November 26, 2000	0.8 – 1.4	< 2 year
December 16, 2000	0.2 – 0.8	< 2 year
January 4, 2001	.04 – 0.9	< 2 year

A. Source Seattle Intensity-Duration-Frequency Curve 1903-1951

According to the 2000/2001 WWTM, the I/I Program conducted two separate analyses on the flow monitoring data to achieve two different objectives. One analysis evaluated each minibasin on the basis of its 30-minute peak total I/I (flow other than base wastewater is called total I/I), and the other analysis evaluated each minibasin on the basis of its Rainfall Dependent I/I (RDII). The objective of determining the 30-minute peak total I/I is to evaluate each minibasin with respect to King County's "excess flow" standard, which defines "excess flow" as flow other than wastewater exceeding 1,100 gallons per acre per day for any 30-minute period. The purpose of evaluating RDII is to establish a ratio of rainfall to I/I that is unique to each minibasin. RDII is the I/I due exclusively to the rain event and excludes antecedent conditions.

This report focuses on the 30-minute peak total I/I values, because antecedent conditions contribute significantly to peak wet weather flows, and the South Sammamish Basin I/I model includes antecedent conditions in its projections (i.e. continuous I/I modeling rather than single event modeling). In the early stages of the Regional I/I Program, observed I/I values will be compared to the projected I/I values to begin identifying modeling basins exhibiting I/I values notably different than projected values. Once the Regional I/I Program's hydraulic model has been calibrated and a comparison of projected and observed I/I values indicates a notable discrepancy, the South Sammamish Basin flow projections will be refined to reflect observed conditions, and these refined flow projections will be used for final facility sizing calculations.

The following list summarizes this report's objectives for evaluating the Regional I/I Program's I/I data in the South Sammamish basin:

- Graphically show the I/I Program's I/I minibasins with respect to the South Sammamish modeling basins (Bellevue 1, 2, 3, Issaquah 1, 2 and Sammamish Plateau)

- Compare King County's projected peak total I/I flow values to the I/I Program's measured I/I flow values.

- "Flag" minibasins exhibiting higher relative I/I values. Although the I/I Program does not plan to develop model calibrations at the minibasin level, the relative I/I values should point to leakier parts of the modeling basins.

Data from the I/I Program (presented as Appendix A and Appendix B in the 2000/2001 WWTM) was processed in GIS to address these objectives. Seventy (70) I/I minibasins fall within the South Sammamish Basin (Figure 18). The four 30-minute peak total I/I values were averaged for each minibasin. Based on its geographical location, each minibasin was then assigned to a modeling basin and the average I/I values for each minibasin were summed for comparison to the projected modeling basin I/I value. Table 18 compares the 5-year I/I flow projections to the I/I Program's 30-minute peak total I/I flows measured during the 2000/2001 wet season. As Table 18 indicates, the rainfall return frequency of the four storm events during the 2000/2001 monitoring period is considered less than 2-year events.

Table 18. Peak Total I/I Comparison

	Year 2000 Peak Total I/I (gpad)	
South Sammamish Modeling Basin	Projected 5-yr	I/I Program's 30-Minute Average Minibasin <2-yr
Sammamish Plateau	900	794
Issaquah 1	3,100	1,448
Issaquah 2	1,600	947
Bellevue 1	1,800	1,082[A]
Bellevue 2	1,800	1,112
Bellevue 3	1,800	769

A. Minibasin BEL038 exhibited extremely high I/I values (9,140 gpad and 40,007 gpad for the December 16, 2000 and January 3, 2001 storm events, respectively) with respect to the other minibasins within modeling basin Bellevue 1. Because the projected 5-year I/I flow values were developed assuming a consistent I/I response over an entire modeling basin, minibasin BEL038 was excluded for this comparative purpose. The 30-minute average peak total I/I would be 2,648 gpad if BEL038 were included.

As expected, the average 30-minute peak total I/I values are all less than the projected 5-year values. Also, except for minibasin BEL038 (in South Sammamish modeling basin Bellevue 1), there does not appear to be any major discrepancies between the two I/I values. At this time, the flow projections outlined in the previous section do not require refinement.

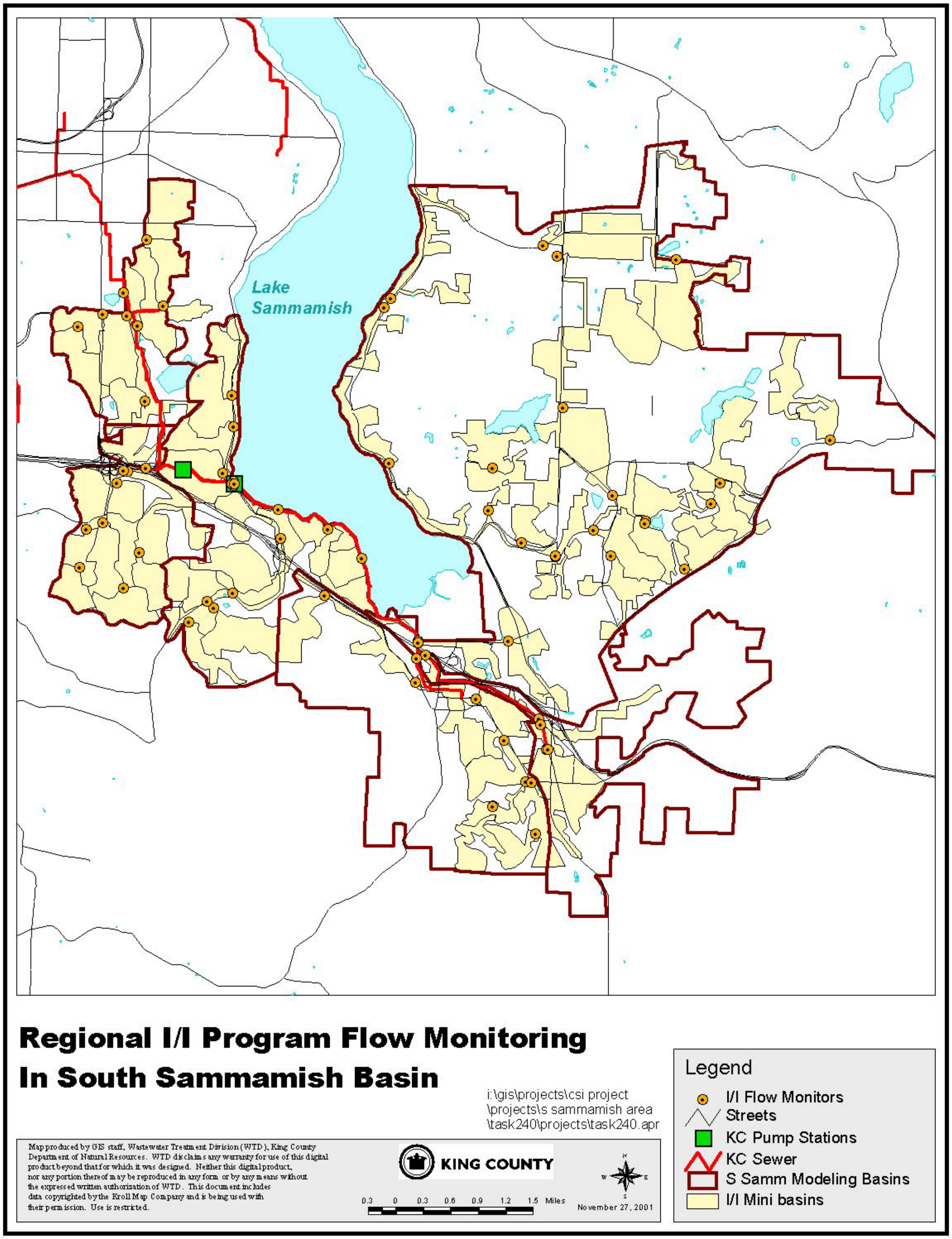


Figure 18. South Sammamish Basin Regional I/I Program Flow Monitoring Summary

Three 30-minute peak total I/I figures were used to depict minibasins with high I/I rates (Figure 19 to Figure 21). To identify minibasins exceeding King County's "excess flow" standard, the figures use three separate "screening" I/I rates and show the number of times flow exceeded the screening threshold during the monitoring period. The screening thresholds are 1,100 gpad, 3,000 gpad, and 5,000 gpad. A minibasin was included in a grouping when at least one of the four storm events yielded a 30-minute peak total I/I value greater than the grouping's minimum limit value. Figure 19 shows 35 minibasins exceeded 1,100 gpad at least once. Figure 20 shows four minibasins that exceeded 3,000 gpad at least once. Figure 21 shows one minibasin exceeded 5,000 gpad at least once.

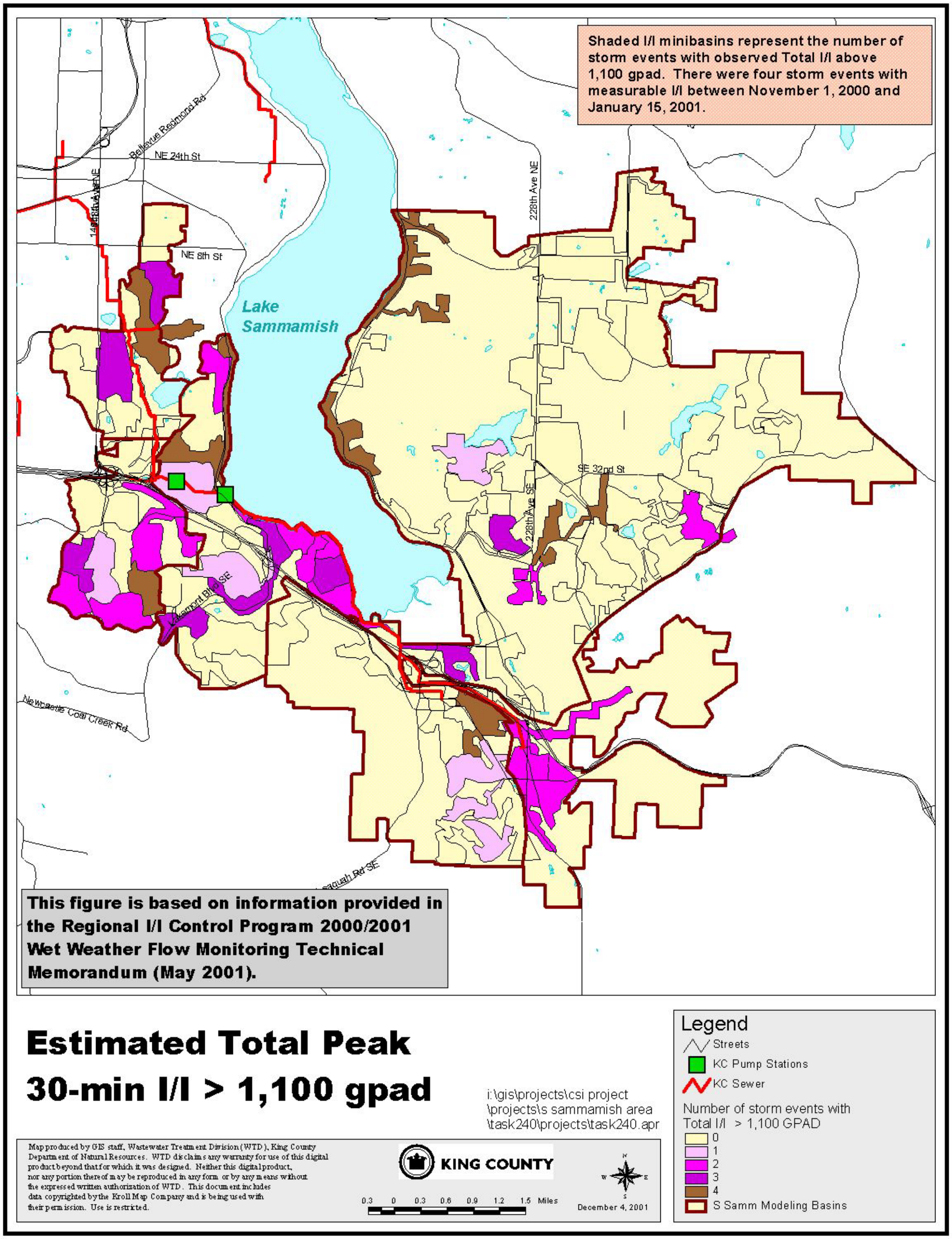


Figure 19. Minibasins With I/I Greater Than 1,100 gpad

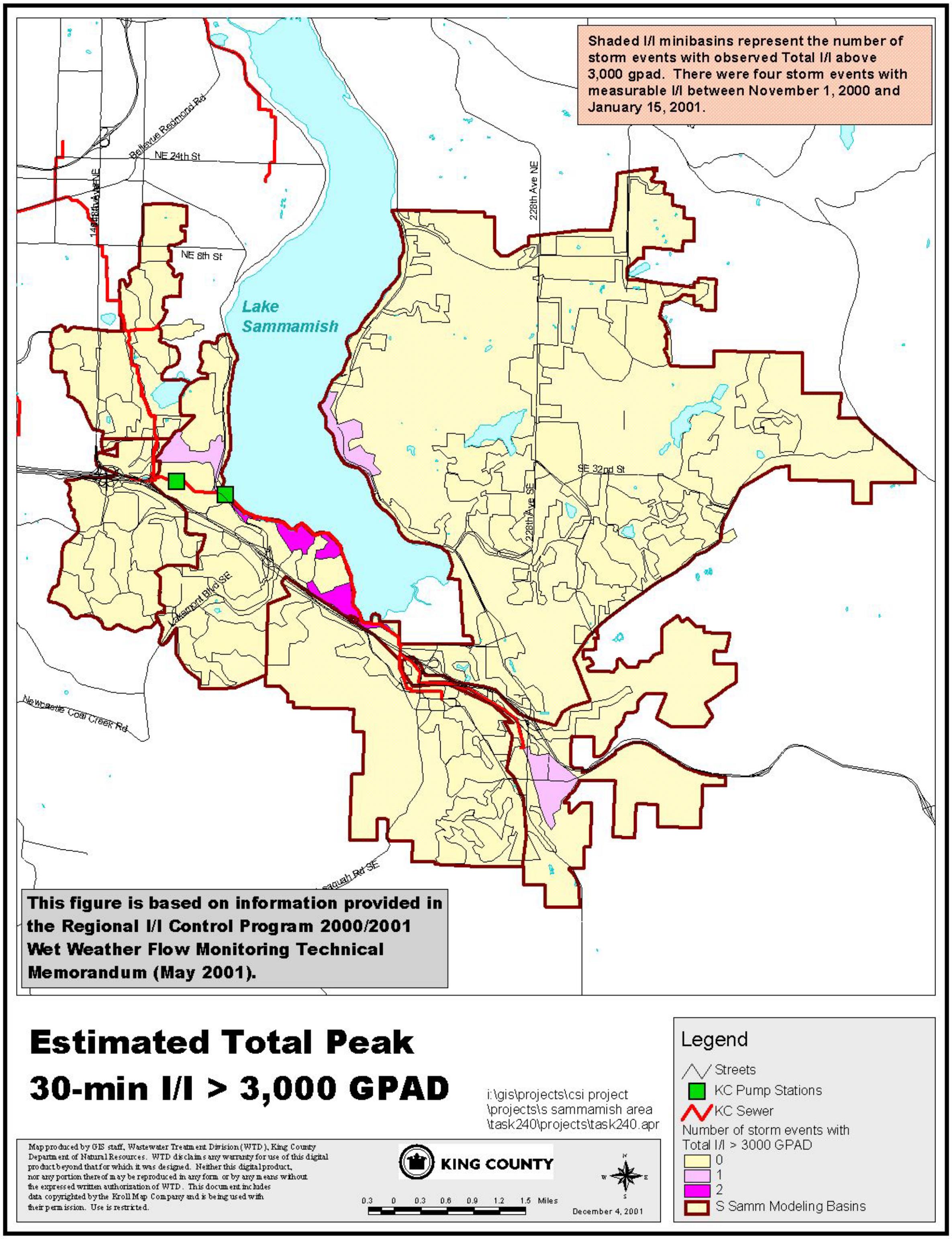


Figure 20. Minibasins With I/I Greater Than 3,000 gpad

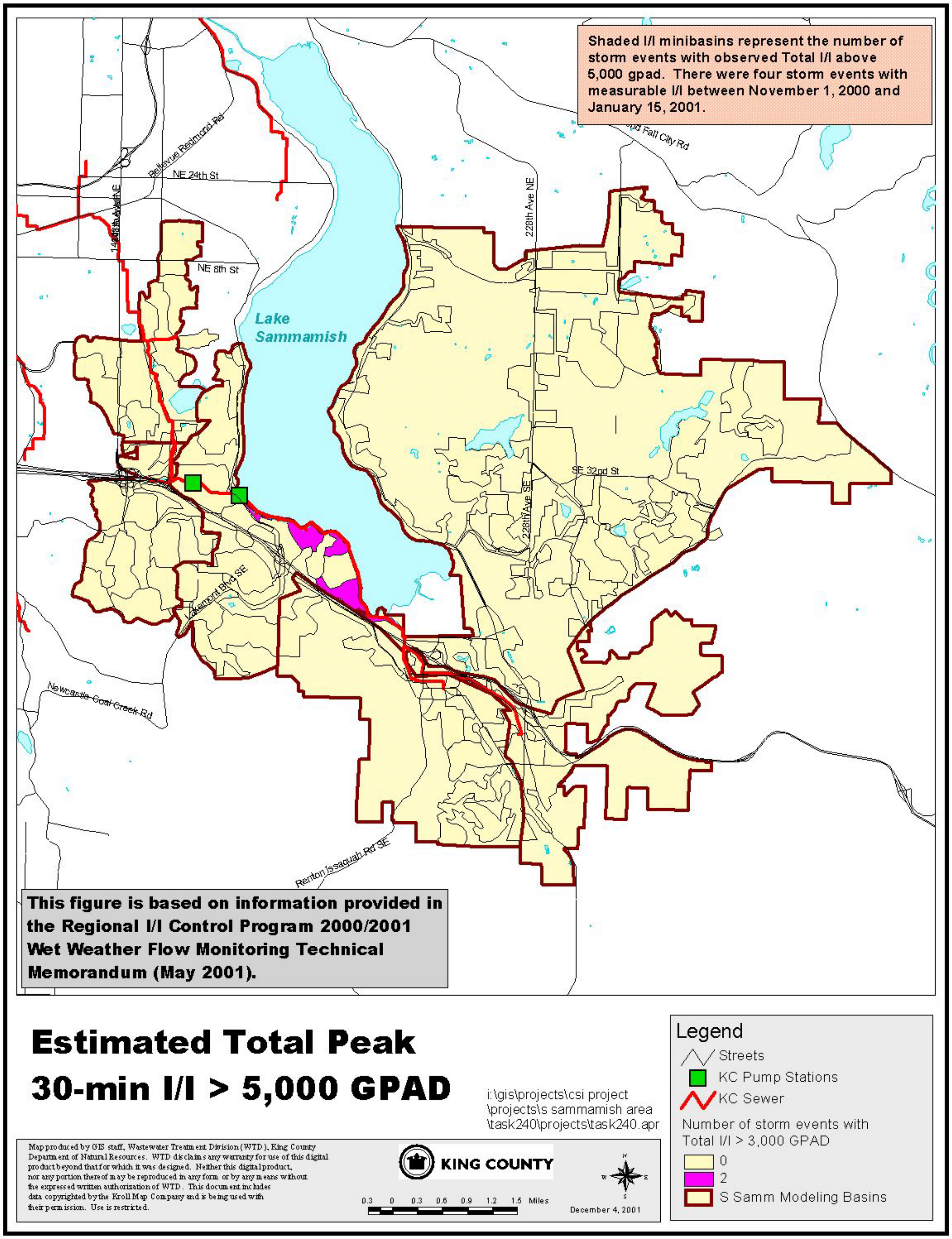


Figure 21. Minibasins With I/I Greater Than 5,000 gpad

While normalizing I/I rates in terms of area is a standard and useful measure, I/I rates can also be estimated relative to the upstream length of sewer. This measure helps to compensate for the differences in development density between minibasins. According to the 2000/2001 WWTM, a range of 2 to 5 gallons per lineal foot (gplf) is a common threshold that separates "tight" minibasins from "leaking" minibasins. As such, two figures were developed to depict minibasins that exhibited RDII values[8] greater than 2 gplf and greater than 5 gplf. Similar to the 30-minute peak total I/I groupings, a minibasin was included in one of the two RDII groupings when at least one of the four storm events yielded a RDII value greater than the grouping's minimum limit value. Figure 22 shows 30 minibasins that exhibited RDII values greater than 2 gplf, and Figure 23 shows 6 minibasins that exhibited RDII values greater than 5 gplf.

[8] The 2000/2001 WWTM used RDII flow rather than total I/I when computing the volume of I/I per lineal foot of pipe.

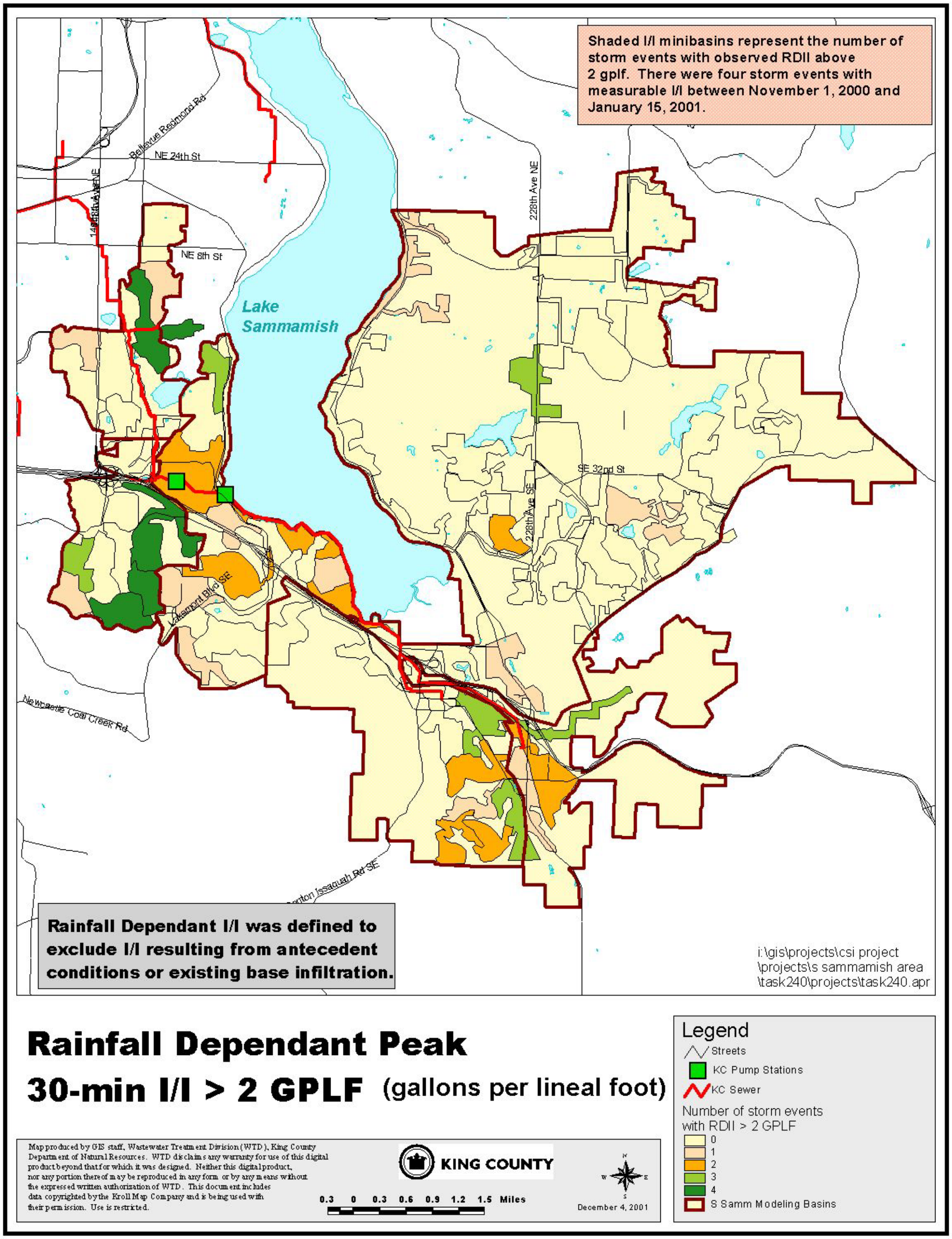


Figure 22. Minibasins With I/I Greater Than 2 Gallons Per Lineal Foot

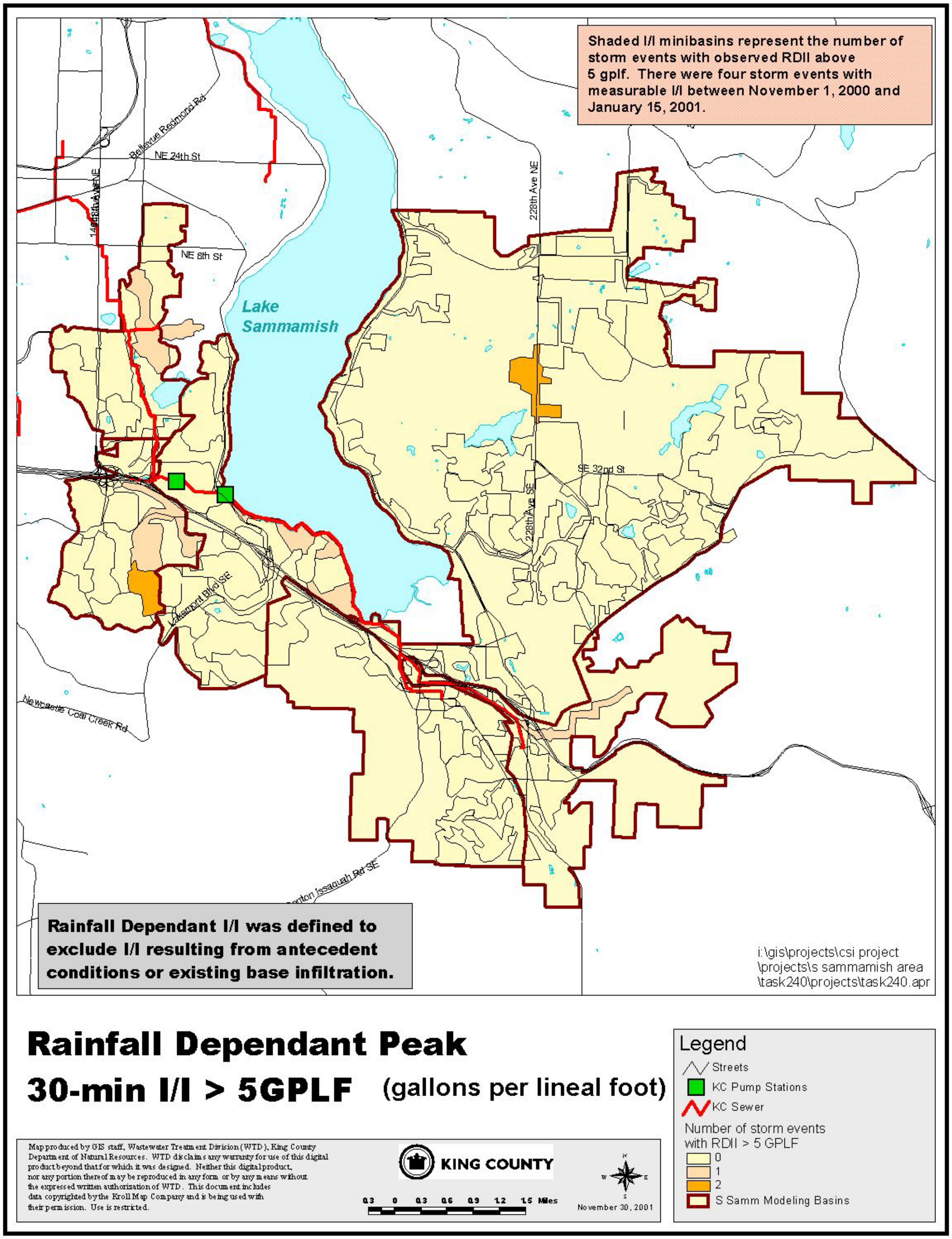


Figure 23. Minibasins With I/I Greater Than 5 Gallons Per Lineal Foot

The Regional I/I Program data show the amount of I/I entering the conveyance system varies across the South Sammamish Basin. In general, the newer sewer systems installed in the Sammamish Plateau WSD service area have the least I/I, while the older sewers in Issaquah and Bellevue have higher amounts of I/I. Table 19 lists the minibasins that exhibited the highest I/I rates during the 2000/2001 monitoring period. These minibasins warrant further investigation for I/I removal.

Table 19. Minibasins With Highest I/I Rates in South Sammamish Basin

Minibasin	30-Minute Peak Total I/I		Rainfall Dependent I/I	
	No. Events >= 3,000 gpad	Observed Maximum (gpad)	No. Events >= 5 gplf	Observed Maximum (gplf)
SAM018			2	5.3
BEL012			1	5.4
BEL038	2	40,007	1	28.2
BEL011			2	7.9
ISS007			1	7.2
BEL109			1	5.2
SAM005	1	3,725		
BELO41	1	3,537		
ISS006	1	3,343		

Alternative H: Reclaimed Water Production and Discharge in the Basin

A reclaimed water production facility could produce high-quality effluent for discharge within the basin, thus limiting flows to downstream facilities. In order for this alternative to be viable, it would have to be considered in conjunction with regional water supply issues. To be feasible, this project would have to include a summertime treatment component and either reclaimed water sales opportunity or another regional environmental benefit. During the winter when there is no market for irrigation water or need for stream flow augmentation; effluent would be discharged into infiltration basins.

The area tributary to the Issaquah Creek Interceptor is one potential site where reclaimed water production could meet several aims. A 2 mgd facility, implemented along with Alternative I, below, could reduce the peak 20-year flow so that no additional capacity would be required in the Issaquah Creek Interceptor through 2050. During the summertime, the reclaimed water plant could augment stream flow in nearby Issaquah Creek.

Before conducting a detailed evaluation of the costs and conveyance system benefits of reclaimed water production, the CSI project team should gauge the likely local perception of the project. Both Issaquah and the Sammamish Plateau use groundwater as their primary source of domestic water. Additionally, discharging treated wastewater in the Lake Washington/Lake Sammamish drainage is currently prohibited by statute. The County would have to obtain a waiver or exemption before constructing a reclaimed water production facility.

Alternative I: Preserving Capacity in the Issaquah Creek Interceptor

This alternative preserves capacity in the Issaquah Creek Interceptor by either increasing the capacity of the existing conveyance or by diverting wastewater away from the current alignment. The Issaquah Creek Interceptor will reach its conveyance capacity before any other King County facility in the South Sammamish Basin (see Figures 5 and 9). By 2010, the 561-foot long pipe section between manholes R17-47 and R17-46 will not have enough capacity to convey the peak 20-year flow without surcharging. By 2020, the 7359 feet of pipe from manhole R17-54A to manhole R17-38A will not have enough capacity to convey the peak 20-year flow. This section describes two methods of managing the capacity shortfall in the Issaquah Creek Interceptor: (1) increasing the capacity of the existing interceptor and (2) diverting a portion of the tributary flow to SE 56th Street.

Alternative I1

This alternative would replace the overcapacity portions of the Issaquah Creek Interceptor with a parallel line. The parallel piping can be sized in coordination with specific I/I reduction goals. For example, without I/I reduction, an 18-inch diameter pipe will provide enough additional capacity through 2050. If King County and the City of Issaquah reduce I/I by 30 percent, the parallel piping can be delayed until 2020, and its diameter can be reduced to 12 inches. While the timing of the parallel construction can be affected by I/I reduction, the total length of paralleled will be similar under each scenario.

Alternative I2

The Issaquah Highlands currently drains through local sewers to the Issaquah Creek Interceptor. Our hydraulic analysis, based on the County's GIS data and flow projections, showed the Issaquah Creek Interceptor will have segments beyond their Manning's full-pipe capacity by 2010 (for 20-year peak flow). By 2020, almost all of the interceptor will be beyond its Manning's full-pipe capacity due largely to forecasted development in the area.

Expanding or paralleling the Issaquah Creek Interceptor would involve challenging construction, because the interceptor runs along a heavily commercialized street, Gilman Boulevard. CSI alternatives that can delay or eliminate the need for extra capacity in this interceptor are preferable. Rerouting the Issaquah Highlands would lower flow in the Issaquah Creek Interceptor enough to delay capacity upgrades until 2020. In the interim, King County could incorporate the results of the Regional I/I program and updated information about local sewer development to determine whether an aggressive I/I removal program would eliminate the need for capacity upgrades beyond 2020. Based on currently available information, diverting the Issaquah Highlands and conducting an aggressive I/I removal program that reduces the peak 20-year I/I by 25 percent would control flows so that no capacity upgrades on the Issaquah Creek Interceptor would be necessary before 2050 (the CSI project planning window).

Any northward diversion of the Issaquah Highlands would probably link to the sewer running along SE 56th Street at the south end of Lake Sammamish State Park. Figure 24 shows two possible routes, each of which would use gravity flow to reach SE 56th Street, near E Lake Sammamish Parkway. The key questions to address regarding rerouting the Issaquah Highlands flows are (1) whether the routes shown in Figure 24 are easier to build along than Gilman Boulevard, and (2) how adding flows to the SE 56th Street Interceptor would affect the King County Extension project[9]. Assuming at least one of the diversion routes has construction advantages over the current Issaquah Creek Interceptor alignment, diverting the Issaquah Highlands would add approximately 1.4 mgd to the SE 56th Street line at build out.

The impacts to the King County Extension sewer will differ depending on which alignment is chosen. If the Sammamish Plateau WSD and King County decide to route the King County Extension sewer along SE 56th Street, the new piping should be sized to accept flow from the Issaquah Highlands. If the Extension sewer is routed underneath the park, it is probable that a portion of District wastewater will flow through the siphon under the park and a portion will continue to use the SE 56th Street pipe (according to the District's current plans). The Sammamish Plateau WSD Draft Engineering Report for the King County Extension (dated February 2000) states that the SE 56th piping has a hydraulic capacity between 7.1 and 8.4 mgd (4,900 and 5,800 gpm) depending on the operations of local pump stations. If the Extension sewer is routed under the park, the final sizing of the siphon and the operations of the local sewers should allow for the possible addition of 1.4 mgd from the Issaquah Highlands to the SE 56th Street interceptor.

A preliminary review of the ground profiles for both diversion routes indicates that Diversion Route 2 is a more feasible route to construct. Additionally, Diversion Route 2 (7,200 feet) would be shorter than Diversion Route 1 (approximately 12,000 feet). For cost estimating purposes, Diversion Route 2 will be analyzed and it is assumed that traffic would be considered "light" in the Issaquah Highlands area.

[9] The King County Extension project will construct a new sewer connection between the Sammamish Plateau WSD and King County. The new connection will be sized for build out flows from the Sammamish Plateau.

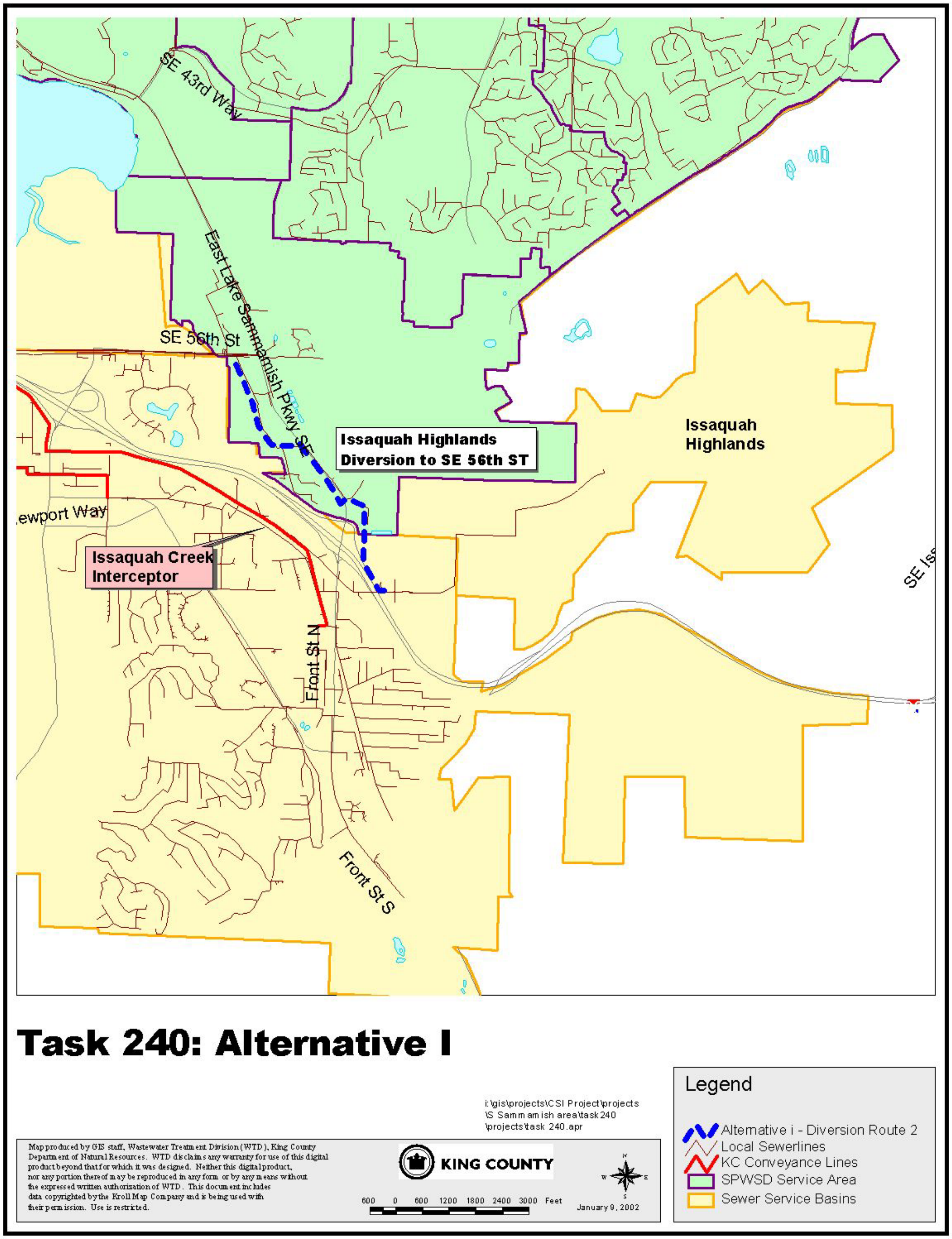


Figure 24. Diversion Routes for the Issaquah Highlands

Table 20 summarizes the information used to develop the Alternative I cost estimate. The 2 mgd flow for Alt I1 represents the additional capacity that would be required by a parallel pipe for the Issaquah Creek Interceptor to convey year 2050, 20-year peak flows (Figure 5). Similarly, the 2 mgd flow for Alt I2 represents the diversion necessary to serve the entire Issaquah Highlands development and provide enough relief to the Issaquah Creek Interceptor to avoid capacity expansion of this interceptor.

Table 20. Alternative I Cost Estimate Summary

	Alt I1	Alt I2
Flow, mgd	2	2
Gravity Sewer Diameter, in	18	15
Gravity Sewer Length, ft	7,360	7,200
Year 2001 Capital Construction Costs	**$2.8M**	**$2.3M**

ROADMAP TO A SOLUTION FOR THE SOUTH SAMMAMISH BASIN

This section is intended to serve as a guide to packaging the alternatives in a way that meets King County's goals of limiting overflows to once per 20 years, staging capital costs, and managing operation and maintenance needs. The tables and figures in this section demonstrate possible combinations of alternatives, giving the opportunity for King County staff to review the options prior to the CSI South Sammamish Basin Decision Workshop.

The Need for Conveyance Improvements

As South Sammamish Basin develops and the sewers in the basin age, the projected peak 20-year flow will increase beyond the existing capacity of numerous King County conveyance facilities. In the Flow Capacity Overview section of this document, Figure 9 showed a schedule of when conveyance facilities would reach capacity, summarized here in Table 21.

Table 21. Schedule of Facilities Reaching Capacity

Conveyance Facility	When Additional Capacity Needed	Additional Capacity Needed in 2020[A]	Additional Capacity Needed in 2050[A]
Issaquah Creek Int.	2010	0.3[B] / 1.6 mgd	2.4 mgd
Issaquah Int. Sec. 2	2020	6.2 mgd	11.8 mgd
Issaquah Int. Sec. 1	2020	8.9 mgd	14.5 mgd
Sunset Pump Station	2010	8.2[C] / 17.2 mgd	23.9 mgd
Heathfield Pump Station	2010	8.2[C] / 17.2 mgd	23.9 mgd
Eastgate Trunk	2020	14.1 mgd	21.7 mgd
Boulevard Siphon	After 2050	0 mgd	0 mgd

A. The additional capacity needed values assume the upstream facilities convey all wastewater to the given interceptor or pump station. If there is a reduction in flow upstream, the effects will cascade through the downstream conveyance.

B. Issaquah Creek Interceptor needs 0.3 mgd of additional capacity in 2010 and 1.6 mgd in 2020.

C. Sunset and Heathfield Pump Stations need 8.2 mgd of additional capacity in 2010 and 17.2 mgd in 2020. The calculations are based on capacity test at Sunset Pump Station that showed a peak throughput of 18 mgd, not the 24 mgd firm capacity in the *1994 King County Offsite Facilities Manual*.

Matching Alternatives with Conveyance Needs by 2010

The alternatives presented in this report are designed to provide relief to specific conveyance facilities. According the Table 21, some capacity relief will be required by either 2010 or 2020 for most of the conveyance facilities in the basin.

Table 22 lists the matrix of alternatives that can provide relief to the Issaquah Creek Interceptor in 2010. Because the Issaquah Creek Interceptor is located farthest upstream, construction on other King County facilities will not impact the Issaquah Creek Interceptor, but construction related to the Issaquah Creek Interceptor capacity can affect other facilities.

Table 22. Matrix of Alternative Combinations for the Issaquah Creek Interceptor

Conveyance Facility	Alt. I1	Alt. I2	Alt C	Alt G
Combination of Alternatives for the Issaquah Creek Interceptor	☑			
		✓	✓	✓
	✓		✓	✓

☑ = Alternative could function alone; ✓ = Alternative must function in combination with others

Alternatives I1 and I2 are the two main alternatives for managing flow in the Issaquah Creek Interceptor. Alternatives C and G (storage and I/I control, respectively) can assist in controlling overflows, but should not be enacted alone[10]. If Alternative I2 is enacted and Issaquah Highlands flow is diverted, upstream I/I control, storage or an addition diversion will be needed after 2030.

The choice between Alternatives I1 and I2 is construction either along Gilman Boulevard or E. Lake Sammamish Parkway. The planning level costs of the two alignments are similar enough that the alignment choice should be based in large part on construction preference. Gilman Boulevard has more commercial businesses and traffic control issues, but the E. Lake Sammamish Parkway route involves construction in a new area where King County WTD does not currently have sewers. This section of E. Lake Sammamish Parkway is a major arterial, but the roadway is multilane, without the same constrictions as the sections of E. Lake Sammamish Parkway farther north adjacent to Lake Sammamish.

The Sunset and Heathfield Pump Stations do not have enough capacity to convey the peak 20-year flow projected for 2010. The capacity test conducted in September 2001 yielded a peak capacity of approximately 18 mgd. The projected peak 5-year and 20-year flows in 2010 are 21.5 mgd and 26.2 mgd, respectively. King County could implement minor station improvements to boost the stations' capacity sufficiently to convey to once per 5 years flow, as an interim step towards bringing all facilities to the County's SSO standard. More major facility upgrades implemented to meet the 2020 conveyance needs (see next section) will bring the Sunset and Heathfield Pump Stations up to the once per 20-year overflow standard. The potential methods for minor upgrades and associated costs will be developed for the Task 250 report, when the Working Alternative is investigated further and refined.

Matching Alternatives with Conveyance Needs by 2020

By 2020, the Issaquah Interceptor Sections 1 and 2, the Sunset and Heathfield Pump Stations, and the Eastgate Trunk will need additional capacity or reduced flow to convey the peak 20-year flow. Many of the alternatives developed will provide relief to these facilities. Table 23 lists the matrix of alternatives that will help if implemented by 2020, and it provides a template for constructing complete conveyance solutions. The major facility upgrades provide a large amount of capacity to the system, while the minor upgrades are designed to provide supplemental capacity, to allow for refinements in the future growth in flow projections, stage capital costs, and in some cases allow for smaller pipes and pump sizes on the major facility upgrades.

[10] Meeting overflow limits by I/I control alone would require removing 2.4 mgd (46 percent) of the peak 20-year I/I in 2050. If SSOs in the Issaquah Creek Interceptor were controlled by storage alone, the storage unit would be operated frequently enough to impact operation and maintenance.

Table 23. Matrix of Alternative Combinations for 2020

	Major Upgrade				Minor Upgrade			
Conveyance Facility	Alt A	Alt B	Alt D	Alt F	Alt C	Alt E	Alt G	Misc. Upgrades
Issaquah Int. S2	✓		☑		✓		✓	✓
Issaquah Int. S1	✓		☑		✓	☑	✓	
Sunset PS	✓	✓	☑	☑	✓		✓	✓
Heathfield PS	✓	✓	☑	☑	✓		✓	✓
Eastgate Trunk	✓	✓	✓		✓	☑	✓	✓

☑ = Alternative could function alone; ✓ = Alternative must function in combination with others

Alternative Package 1

This combination of alternatives focuses on *reducing* the peak flow in the Issaquah Interceptor Section 1 (lake line) and downstream facilities. The reduction in peak flow is accomplished through a combination of flow diversion, peak flow storage and I/I control. The following alternatives are included in Alternative Package 1:

- Alternative A: Diverting Sammamish Plateau north from Inglewood Hills Road
- Alternative I2: Divert Issaquah Highlands away from Issaquah Creek Interceptor
- Alternative C: Peak flow storage in both Issaquah and Sammamish Plateau
- Alternative G: I/I reduction in the Issaquah 1 and Issaquah 2 modeling basins

Alternative Package 1 would be implemented in a phased approach, so that facilities are added or upgraded just in time meet the basins' peak 20-year flow. Table 24 shows the necessary flow reduction for each of the County's facilities in the South Sammamish Basin, as well as the required facility sizes and phasing schedule for Alternative Package 1.

Table 24. Alternative Package 1: Required Flow Reduction Facility Construction

	2010	2020	2030	2040	2050
Required Flow Reduction or Capacity Increase in Each Facility by Decade (mgd):					
Issaquah Creek Interceptor[1]	*0.3*	*1.6*	*1.8*	*2.2*	*2.4*
Issaquah Interceptor Section 2	0.0	6.2	8.2	10.2	11.8
Issaquah Interceptor Section 1	0.4	8.9	10.9	12.9	14.5
Sunset and Heathfield PS's	8.2	17.2	19.7	22.1	23.9
Eastgate Trunk	4.4	14.1	16.9	19.8	21.7
Flow Reduction or Capacity Increase in Each Facility via Alternative Package 1 (mgd)					
Issaquah Highlands Diversion[1] *(Alt I2)*	*0.6*	*1.1*	*1.1*	*1.3*	*1.4*
Sammamish Plateau Diversion (Alt A: Inglewood Hills Road Diversion)	1.9	3.6	4.4	4.6	4.8
Option 1: Without I/I Control:					
1.5 MG Storage: Issaquah (Alt C)	5.5	6.3	6.5	6.7	6.9
1.5 MG Storage: Sammamish Plateau (Alt C)	–	9.0	9.0	9.2	9.3
OR Option 2: With I/I Control:					
1.5 MG Storage: Issaquah (Alt C)	5.5	6.3	6.5	6.7	6.9
0.7 MG Storage: Sammamish Plateau (Alt C)	–	5.0	5.0	5.2	5.4
I/I reduction in Issaquah 1[2] (Alt G)	–	1.2	1.2	1.2	1.7
I/I reduction in Issaquah 2[2] (Alt G)	–	1.0	1.0	1.0	1.5
Total Flow Reduction (mgd)[3] (Opts. 1 and 2):	**7.4[3]/7.4[3]**	**18.9/17.1**	**19.9/18.1**	**20.5/18.7**	**21.0/20.3**
Sunset/Heathfield P.S. 20-Year Control?	No/No	Yes/No	Yes/No	No/No	No/No
Sunset/Heathfield P.S. 5-Year Control?	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes
Other Facilities Within 20-Year Control?	Yes/Yes	Yes/Yes	Yes/Yes	Yes/No	No/No

1. Issaquah Creek Interceptor is only affected by the Issaquah Highlands Diversion and the Issaquah 1 modeling basin I/I reduction.

2. We assumed the Issaquah 1 and Issaquah 2 modeling basins' highest 600 acres have 20-year I/I values of 4,000 gpad, which is 30 to 40 percent higher than the basins' average. If these leakiest sections of the basins were reduced to 1,500 gpad, the total removal would be 1.5 mgd in each basin.

3. The total flow reduction is calculated by summing the Sammamish Plateau Diversion (Alternative A) flow reduction and either the storage and I/I control flow reductions in Option 1 or Option 2. Note: Issaquah Highlands diversion only affects the flow in the Issaquah Creek Interceptor, because flows are routed into the King County system downstream.

Cost Estimates – Alternative Package 1

This section contains construction cost estimates (i.e. does not include KC allied costs, contingencies, etc.) for the set of alternatives described above. All costs were computed using Tabula, the County's planning-level cost estimating tool that was developed for the CSI project. Tabula reports costs in year 2001 dollars (using Seattle's ENR-CCI of 7,340). Table 25 shows the facility sizes, phasing and total construction costs for each phase of Alternative Package 1; Appendix B contains a detailed cost breakdown.

The two different costs estimates in Table 25 reflect the reduction in facility costs that can be achieved by reducing the peak 20-year I/I by 3.0 mgd in Issaquah. Previous King County investigations suggest that removing this amount of I/I from the Issaquah system is a feasible goal. The Regional I/I Program will refine the County's estimates of I/I in the area and provide better resolution between high and low I/I areas in Issaquah so that I/I removal efforts can be targeted in specific areas. As stated in the description of Alternative H, I/I removal costs are highly site specific and variable. Wherever feasible, relatively simple fixes such as roof drain and catch basin disconnection can cost less than $2 per gallon per day (gpd) of peak 20-year I/I removed. Typically, roof drains and catch basins only account for a small portion of total I/I. Other methods of I/I removal, such as sewer lateral repair, foundation drain disconnection and sewer main rehabilitation, are more costly. For planning-level studies, we can assume I/I reduction costs range from $2 to $12 per gpd of the 20-year peak I/I removed. When considering the costs and benefits of I/I removal, it is important to consider not only capital cost savings associated with reduced South Sammamish Basin facilities but also regional benefits, such as reduced stresses on facilities downstream of the South Sammamish Basin, steadier operating conditions at pump stations, treating less 'clean' water at the County's treatment plants, and leaving more water in the basin for aquifer recharge.

Table 25. Alternative Package 1: Facility Construction Sizing and Costs[1]

Facility	Sizing	Year	Cost ($ millions)[2]
Issaquah Highlands Diversion (Alt I2)	Length = 7,200 ft; Diameter = 15 in	2010	2.3
Sammamish Plateau Diversion Gravity Piping[3] (Alt A: Inglewood Hills Road Diversion)	Length = 18,500 ft; Diameter = 24 in	2010	8.5
Storage Tunnel: Issaquah (Alt C)	Option 1 = 1.5 MG/Option 2 = 1.5 MG Tunnel: Length = 1,800 ft; Diam. = 12 ft	2010	8.5/8.5
Storage Tunnel: Sammamish Plateau (Alt C)	Option 1 = 1.5 MG/Option 2 = 0.7 MG 0.7MG:Length = 850 ft; Diam. = 12 ft 1.5MG: Length = 1,800 ft; Diam. = 12 ft	2020	8.5/6.1
Sub-Total 2010		**2010**	**19.3/19.3**
Sub-Total 2020		**2020**	**8.5/6.1**
Total			**27.8/25.4**

1. See Appendix B for detailed cost breakdown. All costs in year 2001 dollars (Seattle ENR-CCI of 7,341)

2. Costs for both "with I/I" and "without I/I" options are shown here, separated by a slash. These estimates do not include the cost of the I/I rehabilitation, only its effects of facility sizing.

3. See description of Inglewood Hills diversion in Alternative A text. Additional routing options should be considered in Task 250.

Alternative Package 2

Alternative Package 2 would bypass the future system bottleneck at Lake Sammamish by constructing a diversion pump station and sewer routed roughly parallel to I-90, connecting the Issaquah Interceptor Section 1 with the Eastside Interceptor Section 8 as described in Alternative D1 (see Figure 16). This alternative package also includes peak flow storage and I/I reduction. The specific diversion and flow management components are as follows:

- Alternative D1: Divert flow along the I-90 corridor to the Eastside Interceptor
- Alternative I2: Divert Issaquah Highlands away from Issaquah Creek Interceptor
- Alternative G: I/I reduction in the Issaquah 1 and Issaquah 2 modeling basins
- Alternative C: Peak flow storage in both Issaquah and Sammamish Plateau

Similar to Alternative Package 1, this combination of alternatives would be phased to meet the conveyance needs in the basin. Table 26 shows the necessary flow reduction for each of the County's facilities in the South Sammamish Basin and resulting flow reduction from each of the component of Alternative Package 2 (both with and without I/I reduction).

Table 26. Alternative Package 2: Required Flow Reduction Facility Construction

	2010	2020	2030	2040	2050
Required Flow Reduction in Each Facility by Decade (mgd):					
Issaquah Creek Interceptor[1]	*0.3*	*1.6*	*1.8*	*2.2*	*2.4*
Issaquah Interceptor Section 2	0.0	6.2	8.2	10.2	11.8
Issaquah Interceptor Section 1	0.4	8.9	10.9	12.9	14.5
Sunset and Heathfield PS's	8.2	17.2	19.7	22.1	23.9
Eastgate Trunk	4.4	14.1	16.9	19.8	21.7
Flow Reduction in Each Facility Resulting from Alternative Package 2 (mgd):					
Issaquah Highlands Diversion[1] (Alt I2)	*0.6*	*1.1*	*1.1*	*1.3*	*1.4*
I-90 Diversion (Alt D1)	10.0	10.0	10.0	10.0	10.0
Option 1: Without I/I Control					
1.3 MG Storage: Issaquah (Alt C)	–	5.9	6.1	6.2	6.4
0.7 MG Storage: Sammamish Plateau (Alt C)	–	–	5.0	5.2	5.4
<u>OR</u> Option 2: With I/I Control					
I/I reduction in Issaquah 1[2] (Alt G)	1.0	1.0	1.0	1.0	1.6
0.7 MG Storage: Issaquah (Alt C)	–	3.5	3.5	4.0	4.0
I/I reduction in Issaquah 2[2] (Alt G)	–	–	–	1.0	1.5
0.7 MG Storage: Sammamish Plateau (Alt C)	–	5.0	5.0	5.2	5.4
Total Flow Reduction (mgd)[3] (Opts. 1 and 2):	**10.0[3]/11.0[3]**	**20.9/19.5**	**21.1/19.5**	**21.4/21.2**	**21.8/22.5**
Sunset/Heathfield P.S. 20-Year Control?	Yes/Yes	Yes/Yes	Yes/Yes	No/No	No/No
Sunset/Heathfield P.S. 5-Year Control?	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes
Other Facilities Within 20-Year Control?	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes

1. Issaquah Creek Interceptor is only affected by the Issaquah Highlands Diversion and the Issaquah 1 modeling basin I/I reduction.

2. We assumed the Issaquah 1 and Issaquah 2 modeling basins' highest 600 acres have 20-year I/I values of 4,000 gpad, which is 30 to 40 percent higher than the basins' average. If these leakiest sections of the basins were reduced to 1,500 gpad, the total removal would be 1.5 mgd in each basin. We assume a cost of $25,000 per acre based on previous project experience, but acknowledge that sewer rehabilitation costs are site specific and highly variable.

3. The total flow reduction is calculated by summing the I-90 Diversion (Alternative D1) flow reduction and either the storage and I/I control flow reductions in Option 1 or Option 2. The minimum of Option 1 and Option 2 is reported. In each case, the components of Alternative Package 1 reduce projected peak 20-year flows to less than the South Sammamish Basin facilities' capacities. Note: Issaquah Highlands diversion only affects the flow in the Issaquah Creek Interceptor, because flows are routed into the King County system downstream.

Cost Estimates – Alternative Package 2

This section contains construction cost estimates (i.e. does not include KC allied costs, contingencies, etc.) for Alternative Package 2. All costs were computed using Tabula, the County's planning-level cost estimating tool that was developed for the CSI project. Tabula reports costs in year 2000 dollars (using Seattle's ENR-CCI of 7,340). Table 27 shows the facility sizes, phasing and total construction costs for each phase of Alternative Package 1; Appendix B contains a detailed cost breakdown.

Table 27. Alternative Package 2: Facility Construction Sizing and Costs[1]

Facility	Sizing	Year	Cost ($ millions)[2]
Issaquah Highlands Diversion (Alt I2)	Length = 7,200 ft; Diameter = 15 in	2010	2.3
I-90 Diversion (Alt D1) FM	Length = 17,500 ft; Diameter = 18 in	2010	5.7
I-90 Diversion (Alt D1) Microtunnel	Length = 12,000 ft; Diameter = 24 in	2010	10.6
I-90 Diversion (Alt D1) PS	Capacity = 10.0 mgd; No. Stations = 2	2010	10.4
Storage Tunnel: Issaquah (Alt C)	Option 1 = 1.3 MG/Option 2 = 0.7 MG 0.7MG:Length = 850 ft; Diam. = 12 ft 1.3MG: Length = 1,600 ft; Diam. = 12 ft	2020	8.0/6.1
Storage Tunnel: Sammamish Plateau (Alt C)	Option 1 = 0.7 MG/Option 2 = 0.7 MG 0.7MG:Length = 850 ft; Diam. = 12 ft	2030	6.1
Sub-Total 2010		**2010**	**29.0**
Sub-Total 2020		**2020**	**8.0/6.1**
Sub-Total 2030		**2030**	**6.1**
Total			**43.1/41.2**

1. See Appendix B for detailed cost breakdown. All costs in year 2001 dollars (Seattle ENR-CCI of 7,341)

2. Costs for both "with I/I" and "without I/I" options are shown here, separated by a slash. These estimates do not include the cost of the I/I rehabilitation, only its effects of facility sizing.

CONCLUSION

This report describes the future flow projections and capacity shortfalls for the King County conveyance facilities in the South Sammamish Basin. The report presents a broad range of increased capacity, demand management, and flow diversion alternatives that can be combined in flexible packages to form a conveyance plan for the future of the South Sammamish Basin. The next stage of the CSI South Sammamish Basin planning effort will involve developing different combinations of these alternatives for evaluation by King County staff. The Task 250 report will contain descriptions of the alternative packaging options, as well as a Working Alternative.

APPENDIX A: FLOW PROJECTION MEMORANDUM FOR THE SOUTH SAMMAMISH BASIN

TECHNICAL MEMORANDUM

King County Department of Natural Resources
Wastewater Treatment Division
Facilities Planning Section

March 9, 2001

To: Lori Jones, Brown and Caldwell CSI Project Manager

From: Mark Lampard, King County Modeling Group

Via: Bob Swarner

Subject: Flow Projection for the South Sammamish Planning Basin

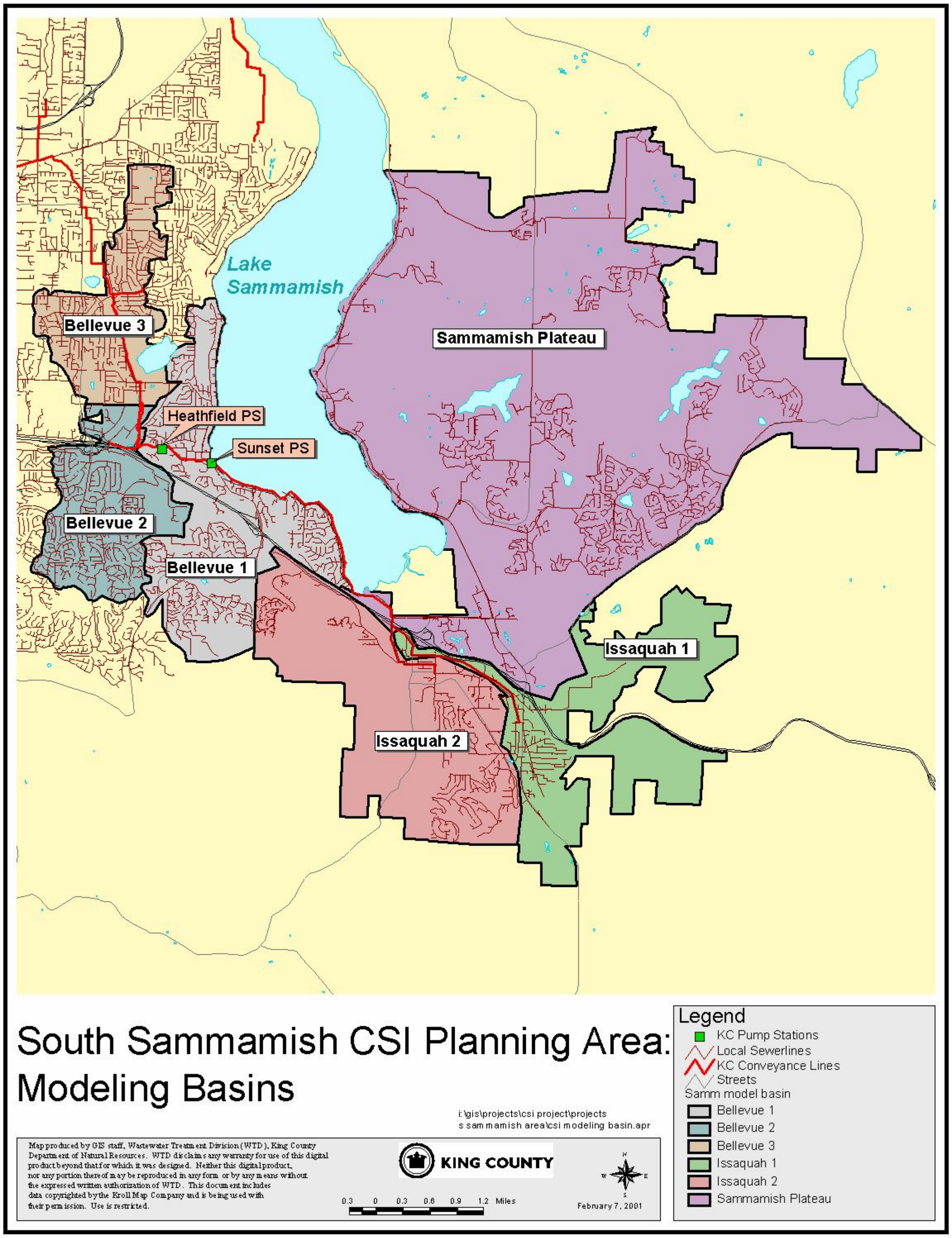
The memorandum provides flow projections for the South Sammamish Planning area. The projected flows have been prepared for the King County Wastewater Treatment Division (WTD) Conveyance System Improvement (CSI) Project. The planning area includes sewer basins served by the Sammamish Plateau Water and Sewer District (SPWSD), the City of Issaquah, and the City of Bellevue.

The planning area is shown in figure 1. The modeling basins shown in the figure are a result of available meter data used in this analysis and do not depict sewer district/municipal boundaries. Information regarding district, city, municipal, and service area boundaries can be found in the respective agency Comprehensive plans.

King County facilities currently conveying flows generated in the South Sammamish Service area include the Issaquah Creek Interceptor, Issaquah Interceptor Section 1 and Section 2, Sunset Pump Station, Heathfield Pump Station, Vasa Park Forcemains, Eastgate Interceptor, and the Lake Hills Interceptor.

Assumptions and methods used for the analysis are summarized below. If you have any questions contact me at (206) 263-3162

Figure 1



Lake Sammamish
Bellevue 3
Heathfield PS
Sunset PS
Bellevue 2
Bellevue 1
Sammamish Plateau
Issaquah 1
Issaquah 2
South Sammamish CSI Planning Area: Modeling Basins
i:\gis\projects\csi project\projects
s sammamish area\csi modeling basin.apr
Map produced by GIS staff, Wastewater Treatment Division (WTD), King County Department of Natural Resources. WTD disclaims any warranty for use of this digital product beyond that for which it was designed. Neither this digital product, nor any portion thereof may be reproduced in any form or by any means without the expressed written authorization of WTD. This document includes data copyrighted by the Kroll Map Company and is being used with their permission. Use is restricted.
KING COUNTY
0.3 0 0.3 0.6 0.9 1.2 Miles
N W E S
February 7, 2001
Legend
KC Pump Stations
Local Sewerlines
KC Conveyance Lines
Streets
Samm model basin
Bellevue 1
Bellevue 2
Bellevue 3
Issaquah 1
Issaquah 2
Sammamish Plateau

Population and Sewered Area Projections.

King County has projected total basin population and sewered area growth within the planning area. Population was projected by apportioning Puget Sound Regional Council (PSRC) Transportation Analysis Zone (TAZ) forecasts for 2000, 2010, 2020, and in the case of residential populations, 2030. Residential sewered population estimates were made from the total basin estimate assuming a direct proportion to the sewered area. Commercial and Industrial estimates were assumed fully sewered through all of the projections. Population forecasts for the 2030, 2040, and 2050 were extrapolated from the TAZ data. TAZ population estimates for the modeled sewer basins are listed below.

King County and CSI project staff met with staff from the Sammamish Plateau Water and Sewer District (SPSWD) and the City of Issaquah personnel to discuss similarities and differences between the King County TAZ based population projections, projection values assumed by the Agencies for their Comprehensive Planning efforts, and their sewered area growth assumptions. Due to differences in projected population growth rates, both sets of data and resultant flow projections are being presented in this memorandum.

The values used for agency projections are those that apply to the given modeled area and presented in Table 4 of the task 210 report for the South Sammamish Planning area (rev8). Intermediate values by decade were interpolated and extrapolated based on growth rates presented in the analysis. For current agency population values, 1999-2000 King County billing records for Single Family Residential (SFR) and Residential Customer Equivalent (RCE) were multiplied by 2.75 persons per SFR/RCE for the current populations (year 2000).

For the purpose of agency population comparisons to TAZ values, the two Issaquah basins were combined due to lack of specific current population distributions between the basins for the billing record population estimates.

In both the TAZ and Agency projections, the sewereable area is assumed to be fully sewered by the year 2020. Sewerable area is the projected sewer basin minus unsewerable areas. Unsewerable areas are based on available information for open space, parks, major transportation corridors and currently undeveloped sensitive areas including lakes, wetlands, streams, steep slopes, and flood plains.

The comparison of Agency estimates to PSRC TAZ for Sammamish Plateau and Issaquah are listed in Tables 1 and 2 below. The estimates for the Bellevue basins are listed in Tables 3, 4 and 5. The City of Bellevue uses the PSRC TAZ estimates, so population estimates don't differ in these basins

Table 1 Sammamish Plateau Water and Sewer District population and sewered area estimates

Sammamish Plateau	Population using PSRC TAZ				Population w/ Agency estimates	Sewered area
Year	Residential	Sewered Residential	Commercial	Industrial	(residential eq.)	(acres)
2000	29,942	20,680	7,172	338	24,495	3,880
2010	32,421	27,406	8,366	488	53,512	7,028
2020	35,940	35,940	9,430	563	71,022	10,175
2030	38,389	38,389	10,308	646	77,024	10,175
2040	41,604	41,604	11,272	729	83,025	10,175
2050	44,601	44,601	12,263	815	89,027	10,175

Total area 12,925 ac. Unsewerable area 2,750 ac.

Table 2. Issaquah Population and sewered area estimates

Issaquah	Population using PSRC TAZ				Population w/ Agency estimates	Sewered area
Year	Residential	Sewered Residential	Commercial	Industrial	(residential eq.)	(acres)
2000	10,104	7,508	6,660	917	10,104	1,935
2010	11,110	9,683	7,943	954	19,928	2,958
2020	12,549	12,549	8,634	1,036	29,752	3,980
2030	13,542	13,542	9,686	1,080	31,713	3,980
2040	14,743	14,743	10,650	1,136	33,674	3,980
2050	15,908	15,908	11,616	1,189	35,635	3,980

Total area 5,690 ac. Unsewerable area 1710 ac.

Table 3. Bellevue 1 Population and sewered area estimates

Bellevue 1	PSRC TAZ population				Sewered area
Year	Residential	Sewered Residential	Commercial	Industrial	(acres)
2000	12,439	11,244	3,058	2,285	1,800
2010	13,319	12,679	3,400	2,298	2,014
2020	13,943	13,943	3,539	2,265	2,228
2030	14,455	14,455	3,733	2,266	2,228
2040	15,460	15,460	3,923	2,258	2,228
2050	16,256	16,256	4,117	2,249	2,228

Total area 2,478 ac. Unsewerable area 250 ac.

Table 4. Bellevue 2 population and sewered area estimates,

Bellevue 2	PSRC TAZ population				Sewered area
Year	Residential	Sewered Residential.	Commercial	Industrial	(acres)
2000	9,251	8,991	2,857	375	2,520
2010	9,785	9,648	3,220	377	2,595
2020	9,988	9,988	3,337	371	2,670
2030	10,020	10,020	3,552	371	2,670
2040	10,528	10,528	3,750	370	2,670
2050	10,846	10,846	3,951	370	2,670

Total area 2,920 ac. Unsewerable area 250 ac.

Table 5. Bellevue 3 population and sewered area estimates,

Bellevue 3	PSRC TAZ population				Sewered area
Year	Residential	Sewered Residential.	Commercial	Industrial	(acres)
2000	9,977	9,550	6,418	384	1,067
2010	10,175	9,957	7,056	393	1,117
2020	10,065	10,065	7,401	394	1,167
2030	9,954	9,954	7,845	407	1,167
2040	10,240	10,240	8,278	415	1,167
2050	10,343	10,343	8,712	422	1,167

Total area 1,417 ac. Unsewerable area 250 ac.

Base Sanitary Flow

Base sanitary flows have been estimated for the planning area by applying the standard King County estimates of unit flows for residential, commercial, and industrial population figures. The standard King County unit flow factors are 60 gallons per capita per day (gpcd) for residential, 35 gallons per employee per day (gped) for commercial and 75 gped for industrial. The King County flow factors agreed well with available monitoring data for the portion of the sewer basin served by the City of Bellevue.

The basin areas served by the SPWSD and The City of Issaquah appears to have a higher per capita flow than the standard factors. Applying a flow factor of 80 gallons per capita per day for residential population agreed with the flow data available and was used for model calibration. Flow projections have been based on this assumed per capita flow.

The non-storm diurnal pattern for the Sammamish Plateau flow data showed consistently higher peak values for the weekend flows. The model was modified to better match the exhibited pattern for the Sammamish Plateau basin calibration.

Table 6 Average base flow estimates

Base flow by Model Basin							
Year	Sammamish Plat.		Issaquah		Bellevue #1	Bellevue #2	Bellevue #3
	TAZ	Agency	TAZ	Agency			
2000	1.93	1.96	0.89	0.81	0.95	0.67	0.83
2010	2.52	4.28	1.12	1.59	1.05	0.72	0.87
2020	3.25	5.68	1.38	2.38	1.13	0.74	0.89
2030	3.48	6.16	1.50	2.54	1.17	0.75	0.90
2040	3.78	6.64	1.64	2.69	1.23	0.79	0.94
2050	4.06	7.12	1.77	2.85	1.29	0.82	0.96

Infiltration/Inflow

Infiltration and inflow (I/I) estimates were made for the planning area by using the King County WTD RUNOFF and RUNOFF/TRANSPORT models. Flow records from a variety of sources were analyzed together with rainfall data from nearby King County rain gauges. After calibration, a 51 year rainfall record from the Sea-Tac rain gauge was used to compute hourly flows. Peak hourly flows associated with rainfall events in the long term simulation were extracted from the data, rank ordered and assigned probability of occurrence. Peak flow rates with return periods of 5 and 20 years were then estimated. Peak I/I rates were determined by subtracting calibrated average baseflow values from the 5 and 20 year peaks. The peak I/I flow rates were then divided by the modeled sewered area to determine the I/I rate in gallons per acre per day (gpad). The current I/I for the modeled basins based on the calibrations are the year 2000 values listed in the flow projection summary tables.

The flow data for the SPWSD and Issaquah service areas were provided by SPWSD and covered a time period from mid December 1999 through mid February 2000. Data from King County's Sunset pump station was used for the Bellevue 1 sewer basin for the same time period. The Sammamish Plateau, Issaquah 1 and Issaquah 2 sewer basins were combined with the Bellevue 1 basin using the KC WTD TRANSPORT model for calibration to the Sunset pump station. The Sammamish Plateau and Issaquah basins were calibrated at that point to the portable meter data and final calibration to the Sunset pump station data was achieved by adjusting parameters in the Bellevue 1 basin. The resulting calibrated Bellevue 1 basin was run by itself with the long term Sea-Tac rain fall record to determine its peak I/I rates.

Flow data was not available for the Bellevue 2 and Bellevue 3 basins and they were not calibrated for this planning study. The existing I/I rate calibrated in the Bellevue 1 basin has been applied to the Bellevue 2 and Bellevue 3 basins.

Calibration and regression plots are attached as figures 2 through 10.

The model of the basins upstream of Sunset pump station was verified to the Thanksgiving storm in November of 1998. A plot of the verification is included as figure 11.

Total Flow Projections

The flow values for base flow and I/I by decade are combined to give total flow projections by basin for the planning area.

Future sewered areas have been assigned an I/I rate of 1600 gpad. This includes 1100 gpad, the amount above which KC can place a surcharge on the excess flow. It also includes 500 gpad to consider the possibility that the excess flow could occur during the peak of the daily diurnal flow assuming a daily dry weather peaking factor of 2 applied to the average base flow of 500 gpad.

The I/I is degraded at 7% per decade, non compounded, up to a maximum of 28%. Newly sewered areas are not degraded until the decade following the assumed sewering.

The I/I values listed in the tables below are composite for the modeled, new and degraded I/I. the peak flows are I/I plus average base flow.

Table 7. Sammamish Plateau with PSRC TAZ population projections

Year	Base flow (mgd)	sewered area (ac)	5yr I/I (gpad)	5yr Peak (mgd)	20yr I/I (gpad)	20yr Peak (mgd)
2000	1.93	3,880	900	5.4	1100	6.2
2010	2.52	7,028	1100	10.3	1400	12.4
2020	3.25	10,175	1200	15.5	1500	18.5
2030	3.48	10,175	1200	15.7	1600	19.8
2040	3.78	10,175	1300	17.0	1700	21.1
2050	4.06	10,175	1400	18.3	1800	22.4

Table 8. Sammamish Plateau with Agency population projections

Year	Base flow (mgd)	sewered area (ac)	5yr I/I (gpad)	5yr Peak (mgd)	20yr I/I (gpad)	20yr Peak (mgd)
2000	1.96	3,880	900	5.5	1100	6.2
2010	4.28	7,028	1100	12.0	1400	14.1
2020	5.68	10,175	1200	17.9	1500	20.9
2030	6.16	10,175	1200	18.4	1600	22.4
2040	6.64	10,175	1300	19.8	1700	23.9
2050	7.12	10,175	1400	21.4	1800	25.4

Tables 9 and 10 summarize flow from the modeled Issaquah 1 and Issaquah 2 basins using the PSRC TAZ population projections.

Table 9. Issaquah 1 TAZ population projections

Year	Base flow (mgd)	sewered area (ac)	5yr I/I (gpad)	5yr Peak (mgd)	20yr I/I (gpad)	20yr Peak (mgd)
2000	0.26	550	3100	2.0	3800	2.3
2010	0.33	1,165	2200	2.9	2800	3.6
2020	0.42	1,780	2000	3.0	2500	4.9
2030	0.45	1,780	2100	4.2	2600	5.1
2040	0.49	1,780	2200	4.4	2800	5.5
2050	0.53	1,780	2300	4.6	2900	5.7

Table 10. Issaquah 2 TAZ population projections

year	Base flow (mgd)	sewered area (ac)	5yr I/I (gpad)	5yr Peak (mgd)	20yr I/I (gpad)	20yr Peak (mgd)
2000	0.67	1,385	1600	2.9	2100	3.6
2010	0.80	1,793	1600	3.7	2100	4.6
2020	0.97	2,200	1600	4.5	2100	5.6
2030	1.05	2,200	1700	4.8	2300	6.1
2040	1.15	2,200	1800	5.1	2400	6.4
2050	1.24	2,200	1800	5.2	2400	6.5

Tables 11 and 12 contain the flow projections for composite of the two Issaquah basins. The I/I values are a weighted average of the two basins. The Tables contain a comparison of the difference between the PSRC TAZ and the Agency population projections on the eventual flows expected from the area.

Table 11. Issaquah composite with TAZ population projections

year	base flow (mgd)	Sewered area (ac)	5yr I/I (gpad)	5yr Peak (mgd)	20yr I/I (gpad)	20yr Peak (mgd)
2000	0.90	1,935	2000	4.8	2600	5.9
2010	1.12	2,958	1900	6.7	2400	8.2
2020	1.38	3,980	1900	8.9	2300	10.5
2030	1.50	3,980	2000	9.5	2400	11.2
2040	1.64	3,980	2100	10.0	2600	12.0
2050	1.77	3,980	2100	10.1	2600	12.1

Table 12. Issaquah Composite with Agency Population projections

year	base flow (mgd)	Sewered area (ac)	5yr I/I (gpad)	5yr Peak (mgd)	20yr I/I (gpad)	20yr Peak (mgd)
2000	0.75	1,935	2000	4.6	2600	5.8
2010	1.74	2,958	1900	7.4	2400	8.8
2020	2.98	3,980	1900	10.5	2300	12.1
2030	3.17	3,980	2000	11.1	2400	12.7
2040	3.37	3,980	2100	11.7	2600	13.7
2050	3.56	3,980	2100	11.9	2600	13.9

The City of Bellevue uses PSRC TAZ to forecast growth. Note that basins Bellevue 2 and Bellevue 3 were not calibrated for this CSI Planning effort. The existing I/I rate calibrated in the Bellevue 1 basin has been applied to the Bellevue 2 and Bellevue 3 basins.

Table 13. Bellevue 1 with TAZ population projections

year	base flow (mgd)	Sewered area (ac)	5yr I/I (gpad)	5yr Peak (mgd)	20yr I/I (gpad)	20yr Peak (mgd)
2000	0.95	1,800	1800	4.2	2200	4.9
2010	1.05	2,014	1800	4.7	2300	5.7
2020	1.13	2,228	1900	5.4	2300	6.3
2030	1.17	2,228	2000	5.6	2500	6.7
2040	1.23	2,228	2100	5.9	2600	7.0
2050	1.29	2,228	2100	6.0	2700	7.3

Table 14. Bellevue 2 with TAZ population projections

year	base flow (mgd)	Sewered area (ac)	5yr I/I (gpad)	5yr Peak (mgd)	20yr I/I (gpad)	20yr Peak (mgd)
2000	0.67	2,520	1800	5.2	2200	6.2
2010	0.72	2,595	1900	5.7	2300	6.7
2020	0.74	2,670	2000	6.1	2500	7.4
2030	0.75	2,670	2100	6.4	2600	7.7
2040	0.79	2,670	2300	6.9	2800	8.3
2050	0.82	2,670	2300	7.0	2800	8.3

Table 15 Bellevue 3 with TAZ population projections

year	base flow (mgd)	sewered area (ac)	5yr I/I (gpad)	5yr Peak (mgd)	20yr I/I (gpad)	20yr Peak (mgd)
2000	0.83	1,067	1800	2.7	2200	3.2
2010	0.87	1,117	1900	3.0	2300	3.4
2020	0.89	1,167	2000	3.2	2400	3.7
2030	0.90	1,167	2100	3.3	2600	3.9
2040	0.94	1,167	2200	3.5	2700	4.1
2050	0.96	1,167	2200	3.5	2700	4.1

Appendix B: Planning-Level Construction Cost Estimates Details from TABULA

Alternative Package 1

Table B1. Alternative Package 1: Facility Construction Sizing and Costs[1]

Facility	Sizing	Year	Cost ($ millions)[2]
Issaquah Highlands Diversion (Alt I2)	Length = 7,200 ft; Diameter = 15 in	2010	2.3
Sammamish Plateau Diversion Gravity Piping[3] (Alt A: Inglewood Hills Road Diversion)	Length = 18,500 ft; Diameter = 24 in	2010	8.5
Storage Tunnel: Issaquah (Alt C)	Option 1 = 1.5 MG/Option 2 = 1.5 MG Tunnel: Length = 1,800 ft; Diam. = 12 ft	2010	8.5/8.5
Storage Tunnel: Sammamish Plateau (Alt C)	Option 1 = 1.5 MG/Option 2 = 0.7 MG 0.7MG:Length = 850 ft; Diam. = 12 ft 1.5MG: Length = 1,800 ft; Diam. = 12 ft	2020	8.5/6.1
Sub-Total 2010		**2010**	**19.3/19.3**
Sub-Total 2020		**2020**	**8.5/6.1**
Total			**27.8/25.4**

1. See Appendix B for detailed cost breakdown. All costs in year 2001 dollars (Seattle ENR-CCI of 7,341)

2. Costs for both “with I/I” and “without I/I” options are shown here, separated by a slash. These estimates do not include the cost of the I/I rehabilitation, only its effects of facility sizing.

3. See description of Inglewood Hills diversion in Alternative A text. Additional routing options should be considered in Task 250.

Issaquah Highlands Diversion (Alt I2)

Cost Calculations for Pipe: Issaquah Highlands Diversion

Project year: 2001

> The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, CM, etc.).

Assumptions

Construction Year: 2001
Length: 7200 ft
Conduit Type: Gravity Sewer
Depth of Cover: 12 ft
Trench Backfill Type: Imported
Manhole Spacing: Average (500 ft)
Existing Utilities: Average
Dewatering: Minimal
Pavement Restoration: Half Width - Residential Street (14 ft)
Traffic: Light
Land Acquisition: None
Required Easements: None
Trench Safety: Standard
Pipe Diameter: 15 in.

Geometry

Outer Diameter	1.67	ft
Trench Width	4.67	ft
Excavation Depth	14.7	ft
Complete Surface Rest. Width	6.67	ft

Unit Costs (Basis 1999)

Item	Quantity	Unit	Unit Cost	ItemCost
Excavation	18,252	CY	10.00	183,000
Backfill	13,689	CY	25.00	342,000
Complete Pavement Restoration	5,333	SY	50.00	267,000
Overlay Pavement Restoration	5,867	SY	20.00	117,000
Trench Safety	211,200	SF	0.50	106,000
Spoil Load and Haul	18,252	CY	10.00	183,000
Pipe Unit Material Cost	7,200	lf	18.00	130,000
Pipe Installation	7,200	lf	20.00	144,000
Place Pipe Zone Fill	3,981	CY	25.00	99,500

Manholes	15	MH	3,000.00	45,000
Existing Utilities	7,200	lf	30.00	216,000
Dewatering	7,200	lf	20.00	144,000
Traffic Control	7,200	lf	5.00	36,000
	Year 1999 subtotal			2,010,000

Mobilization/Demobilization at 10% 1.10
Multiplier from ENRCCI 7137 (1999) to 7341 (2001) 1.03
Effective Multiplier 1.13

Year 1999 subtotal 2,010,000

Total: $2,280,000

Sammamish Plateau Diversion

Cost Calculations for Pipe: Sammamish Plateau Diversion

Project year: 2001

The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, CM, etc.).

Assumptions

Construction Year: 2001
Length: 18500 ft
Conduit Type: Gravity Sewer
Depth of Cover: 12 ft
Trench Backfill Type: Imported
Manhole Spacing: Average (500 ft)
Existing Utilities: Complex
Dewatering: Minimal
Pavement Restoration: Half Width - Residential Street (14 ft)
Traffic: Heavy
Land Acquisition: None
Required Easements: None
Trench Safety: Standard
Pipe Diameter: 24 in.

Geometry

Outer Diameter	2.5	ft
Trench Width	5.75	ft
Excavation Depth	15.5	ft
Complete Surface Rest. Width	7.75	ft

Unit Costs (Basis 1999)

Item	Quantity	Unit	Unit Cost	ItemCost
Excavation	61,067	CY	10.00	611,000
Backfill	43,338	CY	25.00	1,080,000
Complete Pavement Restoration	15,931	SY	50.00	797,000
Overlay Pavement Restoration	12,847	SY	20.00	257,000
Trench Safety	573,500	SF	0.50	287,000
Spoil Load and Haul	61,067	CY	10.00	611,000
Pipe Unit Material Cost	18,500	lf	30.00	555,000
Pipe Installation	18,500	lf	30.00	555,000
Place Pipe Zone Fill	14,366	CY	25.00	359,000
Manholes	37	MH	5,000.00	185,000
Existing Utilities	18,500	lf	80.00	1,480,000

Dewatering	18,500 lf	20.00	370,000
Traffic Control	18,500 lf	20.00	370,000

Year 1999 subtotal 7,520,000

Mobilization/Demobilization at 10% 1.10
Multiplier from ENRCCI 7137 (1999) to 7341 (2001) 1.03
Effective Multiplier 1.13

Year 1999 subtotal 7,520,000

Total: $8,510,000

1.5 MG Storage Tunnel

Cost Calculations for Tunnel: 1.5 MG Tunnel

Project year: 2001

> The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, construction management, etc.). Unless added as an Additional Costs item in the estimate, this cost does NOT include land costs.

Assumptions

Construction Year: 2001
Inside Diameter: 12 ft.
Length: 1800 ft
Dewatering: Significant
Launch Shaft Existing Utilities: Average
Launch Shaft Excavation Depth: 20 ft
Launch Shaft Surface Restoration: Hydroseed
Retrieval Shaft Excavation Depth: 20 ft
Retrieval Shaft Surface Restoration: Hydroseed
Retrieval Shaft Existing Utilities: Average
Tunnel Easement Length: 0 ft
Easement Type: None
Launch Shaft Footprint: Oversized
Retrieval Shaft Footprint: Oversized

Tunnel Geometry

Outer Diameter	13.3	ft
Spoils Volume	9,300	CY

Launch Shaft Geometry

Width	67	ft
Length	160	ft
Footprint	10,700	SF
Volume	7,940	CY
Easement Footprint	18,400	SF

Retrieval Shaft Geometry

Width	54	ft
Length	80	ft
Footprint	4,320	SF
Volume	3,200	CY
Easement Footprint	9,240	SF

Miscellaneous

Spoils Loads 931 loads

Unit Costs (Basis 1999)

Item	Quantity	Unit	Unit Cost	ItemCost
Spoils Haul	9,304	CY	9	83,700
Launch Shaft Excavation	7,941	CY	9	71,500
Launch Shaft Shoring	9,080	SF	41	372,000
Launch Shaft Existing Utilities	10,720	SF	6	64,300
Launch Shaft Backfill	7,941	CY	9	71,500
Launch Shaft Surface Restoration	1,191	SY	5	5,960
Retrieval Shaft Excavation	3,200	CY	9	28,800
Retrieval Shaft Shoring	5,360	SF	41	220,000
Retrieval Shaft Existing Utilities	4,320	SF	6	25,900
Retrieval Shaft Backfill	3,200	CY	9	28,800
Retrieval Shaft Surface Restoration	480	SY	5	2,400
Tunnel Dewatering	1	LS	60,000	60,000
TBM Procurment	1	LS	2,500,000	2,500,000
Tunnel Boring	1,800	ft	2,200	3,960,000

Year 1999 subtotal 7,490,000

Mobilization/Demobilization at 10% 1.10
Multiplier from ENRCCI 7137 (1999) to 7341 (2001) 1.03
Effective Multiplier 1.13

Year 1999 subtotal 7,490,000

Total: $8,480,000

0.7 MG Storage Tunnel

Cost Calculations for Tunnel: 0.7 MG Tunnel

Project year: 2001

The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, construction management, etc.). Unless added as an Additional Costs item in the estimate, this cost does NOT include land costs.

Assumptions

Construction Year: 2001
Inside Diameter: 12 ft.
Length: 850 ft
Dewatering: Significant
Launch Shaft Existing Utilities: Average
Launch Shaft Excavation Depth: 20 ft
Launch Shaft Surface Restoration: Hydroseed
Retrieval Shaft Excavation Depth: 20 ft
Retrieval Shaft Surface Restoration: Hydroseed
Retrieval Shaft Existing Utilities: Average
Tunnel Easement Length: 0 ft
Easement Type: None
Launch Shaft Footprint: Oversized
Retrieval Shaft Footprint: Oversized

Tunnel Geometry

Outer Diameter	13.3	ft
Spoils Volume	4,390	CY

Launch Shaft Geometry

Width	67	ft
Length	160	ft
Footprint	10,700	SF
Volume	7,940	CY
Easement Footprint	18,400	SF

Retrieval Shaft Geometry

Width	54	ft
Length	80	ft
Footprint	4,320	SF
Volume	3,200	CY

Easement Footprint 9,240 SF

Miscellaneous

Spoils Loads 440 loads

Unit Costs (Basis 1999)

Item	Quantity	Unit	Unit Cost	ItemCost
Spoils Haul	4,393	CY	9	39,500
Launch Shaft Excavation	7,941	CY	9	71,500
Launch Shaft Shoring	9,080	SF	41	372,000
Launch Shaft Existing Utilities	10,720	SF	6	64,300
Launch Shaft Backfill	7,941	CY	9	71,500
Launch Shaft Surface Restoration	1,191	SY	5	5,960
Retrieval Shaft Excavation	3,200	CY	9	28,800
Retrieval Shaft Shoring	5,360	SF	41	220,000
Retrieval Shaft Existing Utilities	4,320	SF	6	25,900
Retrieval Shaft Backfill	3,200	CY	9	28,800
Retrieval Shaft Surface Restoration	480	SY	5	2,400
Tunnel Dewatering	1	LS	60,000	60,000
TBM Procurment	1	LS	2,500,000	2,500,000
Tunnel Boring	850	ft	2,200	1,870,000

Year 1999 subtotal 5,360,000

Mobilization/Demobilization at 10% 1.10
Multiplier from ENRCCI 7137 (1999) to 7341 (2001) 1.03
Effective Multiplier 1.13

Year 1999 subtotal 5,360,000

Total: $6,070,000

ALTERNATIVE PACKAGE 2

Table 27. Alternative Package 2: Facility Construction Sizing and Costs[1]

Facility	Sizing	Year	Cost ($ millions)[2]
Issaquah Highlands Diversion (Alt I2)	Length = 7,200 ft; Diameter = 15 in	2010	2.3
I-90 Diversion (Alt D1) FM	Length = 17,500 ft; Diameter = 18 in	2010	5.7
I-90 Diversion (Alt D1) Microtunnel	Length = 12,000 ft; Diameter = 24 in	2010	10.6
I-90 Diversion (Alt D1) PS	Capacity = 10.0 mgd; No. Stations = 2	2010	10.4
Storage Tunnel: Issaquah (Alt C)	Option 1 = 1.3 MG/Option 2 = 0.7 MG 0.7MG:Length = 850 ft; Diam. = 12 ft 1.3MG: Length = 1,600 ft; Diam. = 12 ft	2020	8.0/6.1
Storage Tunnel: Sammamish Plateau (Alt C)	Option 1 = 0.7 MG/Option 2 = 0.7 MG 0.7MG:Length = 850 ft; Diam. = 12 ft	2030	6.1
Sub-Total 2010		**2010**	**29.0**
Sub-Total 2020		**2020**	**8.0/6.1**
Sub-Total 2030		**2030**	**6.1**
Total			**43.1/41.2**

1. See Appendix B for detailed cost breakdown. All costs in year 2001 dollars (Seattle ENR-CCI of 7,341)

2. Costs for both “with I/I” and “without I/I” options are shown here, separated by a slash. These estimates do not include the cost of the I/I rehabilitation, only its effects of facility sizing.

Issaquah Highlands Diversion

See Alternative Package 1 costs above

I-90 Diversion Force Main

Cost Calculations for Pipe: 18" FM Mid

Project year: 2001

The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, CM, etc.).

Assumptions

Construction Year: 2001
Length: 17500 ft
Conduit Type: Force Main
Depth of Cover: 8 ft
Trench Backfill Type: Imported
Manhole Spacing: None
Existing Utilities: Complex
Dewatering: Minimal
Pavement Restoration: Half Width - Residential Street (14 ft)
Traffic: Heavy
Land Acquisition: None
Required Easements: None
Trench Safety: Standard
Pipe Diameter: 18 in.

Geometry

Outer Diameter	1.63	ft
Trench Width	4.61	ft
Excavation Depth	10.6	ft
Complete Surface Rest. Width	6.61	ft

Unit Costs (Basis 1999)

Item	Quantity	Unit	Unit Cost	ItemCost
Excavation	31,764	CY	10.00	318,000
Backfill	20,927	CY	25.00	523,000
Complete Pavement Restoration	12,858	SY	50.00	643,000
Overlay Pavement Restoration	14,365	SY	20.00	287,000
Trench Safety	371,875	SF	0.50	186,000
Spoil Load and Haul	31,764	CY	10.00	318,000
Pipe Unit Material Cost	17,500	lf	30.00	525,000
Pipe Installation	17,500	lf	25.00	438,000
Place Pipe Zone Fill	9,493	CY	25.00	237,000
Existing Utilities	17,500	lf	60.00	1,050,000
Dewatering	17,500	lf	20.00	350,000

Traffic Control	17,500 lf	10.00	175,000

Year 1999 subtotal 5,050,000

Mobilization/Demobilization at 10% 1.10
Multiplier from ENRCCI 7137 (1999) to 7341 (2001) 1.03
Effective Multiplier 1.13

Year 1999 subtotal 5,050,000

Total: $5,710,000

I-90 Microtunnel, Part 1

Cost Calculations for Microtunnel: 24" Microtunnel Mid

Project year: 2001

> The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, CM, etc.) Additional Costs item in the estimate, this cost does NOT include land costs.

Assumptions

Construction Year: 2001
Inside Diameter: 24 in.
Length: 6700 ft
Dewatering: Minimal
Launch Shaft Existing Utilities: Complex
Launch Shaft Excavation Depth: 20 ft
Launch Shaft Surface Restoration: Hydroseed
Retrieval Shaft Excavation Depth: 20 ft
Retrieval Shaft Surface Restoration: Hydroseed
Retrieval Shaft Existing Utilities: Complex
Tunnel Easement Length: 0 ft
Easement Type: None
Traffic: Heavy
Casing Required: false
Number of Intermediate Shafts: 4
Intermediate Shaft Existing Utilities: Complex
Intermediate Shaft Excavation Depth: 20 ft
Intermediate Shaft Surface Restoration: Hydroseed

Tunnel Geometry

Outer Diameter	2.5	ft
Spoils Volume	1,220	CY
Casing Pipe Diameter	N/A	in

Launch Shaft Geometry

Width	17	ft
Length	30	ft
Footprint	510	SF
Volume	378	CY
Easement Footprint	2,820	SF

Retrieval Shaft Geometry

Width	21	ft
Length	21	ft
Footprint	441	SF
Volume	327	CY
Easement Footprint	2,600	SF

Miscellaneous

Spoils Loads 122 loads

Intermediate Shaft Geometry

Width	17	ft
Length	30	ft
Footprint	510	SF
Volume	378	CY
Easement Footprint	2,820	SF

Unit Costs (Basis 1999)

Item	Quantity	Unit	Unit Cost	ItemCost
Spoils Haul	1,218	CY	25	30,500
Launch Shaft Excavation	378	CY	25	9,440
Launch Shaft Shoring	1,880	SF	41	77,100
Launch Shaft Existing Utilities	510	SF	10	5,100
Launch Shaft Backfill	378	CY	25	9,440
Launch Shaft Surface Restoration	57	SY	5	283
Retrieval Shaft Excavation	327	CY	25	8,170
Retrieval Shaft Shoring	1,680	SF	41	68,900
Retrieval Shaft Existing Utilities	441	SF	10	4,410
Retrieval Shaft Backfill	327	CY	25	8,170
Retrieval Shaft Surface Restoration	49	SY	5	245
Intermediate Shaft Excavation	1,511	CY	25	37,800
Intermediate Shaft Shoring	7,520	SF	41	308,000
Intermediate Shaft Existing Utilities	2,040	SF	10	20,400
Intermediate Shaft Backfill	1,511	CY	25	37,800
Intermediate Shaft Surface Restoration	227	SY	5	1,130
MTBM Fixed Costs	1	LS	160,000	160,000
Microtunnel Boring	6,700	ft	624	4,180,000
Tunnel Dewatering	1	LS	75,000	75,000
Traffic Control	6	shaft	25,000	150,000

Year 1999 subtotal 5,190,000

Mobilization/Demobilization at 10% 1.10
Multiplier from ENRCCI 7137 (1999) to 7341 (2001) 1.03
Effective Multiplier 1.13

Year 1999 subtotal 5,190,000

Total: $5,880,000

I-90 Microtunnel, Part 2

Cost Calculations for Microtunnel: 24" Microtunnel I-90 Mid

Project year: 2001

The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, construction management, etc.). Unless added as an Additional Costs item in the estimate, this cost does NOT include land acquisition costs.

Assumptions

Construction Year: 2001
Inside Diameter: 24 in.
Length: 5300 ft
Dewatering: Minimal
Launch Shaft Existing Utilities: Complex
Launch Shaft Excavation Depth: 20 ft
Launch Shaft Surface Restoration: Hydroseed
Retrieval Shaft Excavation Depth: 20 ft
Retrieval Shaft Surface Restoration: Hydroseed
Retrieval Shaft Existing Utilities: Complex
Tunnel Easement Length: 0 ft
Easement Type: None
Traffic: Heavy
Casing Required: false
Number of Intermediate Shafts: 3
Intermediate Shaft Existing Utilities: Complex
Intermediate Shaft Excavation Depth: 20 ft
Intermediate Shaft Surface Restoration: Hydroseed

Tunnel Geometry

Outer Diameter	2.5	ft
Spoils Volume	964	CY
Casing Pipe Diameter	N/A	in

Launch Shaft Geometry

Width	17	ft
Length	30	ft
Footprint	510	SF
Volume	378	CY
Easement Footprint	2,820	SF

Retrieval Shaft Geometry

Width	21	ft
Length	21	ft
Footprint	441	SF
Volume	327	CY
Easement Footprint	2,600	SF

Miscellaneous

Spoils Loads	97	loads

Intermediate Shaft Geometry

Width	17	ft
Length	30	ft
Footprint	510	SF
Volume	378	CY
Easement Footprint	2,820	SF

Unit Costs (Basis 1999)

Item	Quantity	Unit	Unit Cost	ItemCost
Spoils Haul	964	CY	25	24,100
Launch Shaft Excavation	378	CY	25	9,440
Launch Shaft Shoring	1,880	SF	41	77,100
Launch Shaft Existing Utilities	510	SF	10	5,100
Launch Shaft Backfill	378	CY	25	9,440
Launch Shaft Surface Restoration	57	SY	5	283
Retrieval Shaft Excavation	327	CY	25	8,170
Retrieval Shaft Shoring	1,680	SF	41	68,900
Retrieval Shaft Existing Utilities	441	SF	10	4,410
Retrieval Shaft Backfill	327	CY	25	8,170
Retrieval Shaft Surface Restoration	49	SY	5	245
Intermediate Shaft Excavation	1,133	CY	25	28,300
Intermediate Shaft Shoring	5,640	SF	41	231,000
Intermediate Shaft Existing Utilities	1,530	SF	10	15,300
Intermediate Shaft Backfill	1,133	CY	25	28,300
Intermediate Shaft Surface Restoration	170	SY	5	850
MTBM Fixed Costs	1	LS	160,000	160,000
Microtunnel Boring	5,300	ft	624	3,310,000
Tunnel Dewatering	1	LS	60,000	60,000
Traffic Control	5	shaft	25,000	125,000

Year 1999 subtotal 4,170,000

Mobilization/Demobilization at 10% 1.10
Multiplier from ENRCCI 7137 (1999) to 7341 (2001) 1.03
Effective Multiplier 1.13

Year 1999 subtotal 4,170,000

Total: $4,720,000

I-90 Diversion Pump Station No. 1

Cost Calculations for Pump Station: 10 mgd PS

Project year: 2001

The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, construction management, etc.). Unless added as an Additional Costs item in the estimate, this cost does NOT include land acquisition costs.

Assumptions

Construction Year: 2001
Firm Capacity: 10 mgd
Total Dynamic Head: 200 ft
Excavation Depth: 20 ft

Calculated Parameters

Required Pump Power	688 Hp	
Base Architectural/Structural Unit Cost	142,000	$/mgd
Architectural/Structural Unit Cost Adjustment	-65,300	$/mgd
Base Mechanical Unit Cost	123,000	$/mgd
Mechanical Unit Cost Adjustment	33,300	$/mgd

Unit Costs (Basis 1999)

Item	Quantity	Unit	Unit Cost	ItemCost
Site/Civil	1	LS	285,000	285,000
Electrical/Instrumentation	1	LS	1,350,000	1,350,000
Architectural/Structural	10	mgd	77,000	770,000
Mechanical	10	mgd	156,000	1,560,000
High GroundH2O Mitigation	1	LS	1,000,000	1,000,000

Year 1999 subtotal 4,960,000

Multiplier from ENRCCI 7137 (1999) to 7341 (2001) 1.03
Effective Multiplier 1.03
Year 1999 subtotal 4,960,000

Total: $5,100,000

I-90 Diversion Pump Station No. 2

Cost Calculations for Pump Station: 10 mgd PS#2

Project year: 2001

The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, construction management, etc.). Unless added as an Additional Costs item in the estimate, this cost does NOT include land acquisition costs.

Assumptions

Construction Year: 2001
Firm Capacity: 10 mgd
Total Dynamic Head: 220 ft
Excavation Depth: 20 ft

Calculated Parameters

Required Pump Power 757 Hp		
Base Architectural/Structural Unit Cost	142,000	$/mgd
Architectural/Structural Unit Cost Adjustment	-65,000	$/mgd
Base Mechanical Unit Cost	123,000	$/mgd
Mechanical Unit Cost Adjustment	41,700	$/mgd

Unit Costs (Basis 1999)

Item	Quantity	Unit	Unit Cost	ItemCost
Site/Civil	1	LS	285,000	285,000
Electrical/Instrumentation	1	LS	1,450,000	1,450,000
Architectural/Structural	10	mgd	77,300	773,000
Mechanical	10	mgd	164,000	1,640,000
High GroundH2O Mitigation	1	LS	1,000,000	1,000,000

Year 1999 subtotal 5,150,000

Multiplier from ENRCCI 7137 (1999) to 7341 (2001) 1.03
Effective Multiplier 1.03
Year 1999 subtotal 5,150,000

Total: $5,300,000

1.3 MG Storage Tunnel

Cost Calculations for Tunnel: 1.3 MG Tunnel

Project year: 2001

> The estimated construction cost below, which includes contractor overhead and profit, is for planning purposes only. The output does NOT include contingency, sales tax, or allied costs (design, permitting, construction management, etc.). Unless added as an Additional Costs item in the estimate, this cost does NOT include land acquisition costs.

Assumptions

Construction Year: 2001
Inside Diameter: 12 ft.
Length: 1600 ft
Dewatering: Significant
Launch Shaft Existing Utilities: Average
Launch Shaft Excavation Depth: 20 ft
Launch Shaft Surface Restoration: Hydroseed
Retrieval Shaft Excavation Depth: 20 ft
Retrieval Shaft Surface Restoration: Hydroseed
Retrieval Shaft Existing Utilities: Average
Tunnel Easement Length: 0 ft
Easement Type: None
Launch Shaft Footprint: Oversized
Retrieval Shaft Footprint: Oversized

Tunnel Geometry

Outer Diameter	13.3	ft
Spoils Volume	8,270	CY

Launch Shaft Geometry

Width	67	ft
Length	160	ft
Footprint	10,700	SF
Volume	7,940	CY
Easement Footprint	18,400	SF

Retrieval Shaft Geometry

Width	54	ft
Length	80	ft
Footprint	4,320	SF

Volume 3,200 CY
Easement Footprint 9,240 SF

Miscellaneous

Spoils Loads 828 loads

Unit Costs (Basis 1999)

Item	Quantity	Unit	Unit Cost	ItemCost
Spoils Haul	8,270	CY	9	74,400
Launch Shaft Excavation	7,941	CY	9	71,500
Launch Shaft Shoring	9,080	SF	41	372,000
Launch Shaft Existing Utilities	10,720	SF	6	64,300
Launch Shaft Backfill	7,941	CY	9	71,500
Launch Shaft Surface Restoration	1,191	SY	5	5,960
Retrieval Shaft Excavation	3,200	CY	9	28,800
Retrieval Shaft Shoring	5,360	SF	41	220,000
Retrieval Shaft Existing Utilities	4,320	SF	6	25,900
Retrieval Shaft Backfill	3,200	CY	9	28,800
Retrieval Shaft Surface Restoration	480	SY	5	2,400
Tunnel Dewatering	1	LS	60,000	60,000
TBM Procurment	1	LS	2,500,000	2,500,000
Tunnel Boring	1,600	ft	2,200	3,520,000

Year 1999 subtotal 7,050,000

Mobilization/Demobilization at 10% 1.10
Multiplier from ENRCCI 7137 (1999) to 7341 (2001) 1.03
Effective Multiplier 1.13

Year 1999 subtotal 7,050,000

Total: $7,970,000

0.7 MG Storage Tunnel

See Alternative Package 1 costs above